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Weather Deterioration Models Applied To Alternate Airport Criteria

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Final Report

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16. Abstract

Flights under Instrument Flight Rules (IFR) require the filing of a flight plan. The flight plan must contain an alternate airport unless certain conditions at the destination are met. These conditions concern the availability of an instrument approach procedure and anticipated meteorological conditions within one hour of the estimated arrival time. Certain other conditions must be met for an airport to qualify as an alternate airport. These conditions also are based on instrument approach procedure availability and forecast meteorological conditions. Relaxation of the current requirements regarding alternate airports could benefit some aircraft operators by improving schedule reliability and reducing the number of weather related departure delays.

The investigation quantified the increased risk of ceilings and visibilities being below landing minimums at several cities in the conterminus U.S. if requirements are relaxed. The study methods utilized climatology data and weather deterioration models to calculate the probability of an airport being below precision and non-precision approach minimums.

The preliminary findings indicate that relaxing the current alternate airport criteria would increase the risk that an airport would be below landing minimums. It was also shown that this increase in risk could be offset by limiting the relaxation of the regulations to those flights which are of short duration (less than two hours). Possible changes to the current Federal Aviation Regulations regarding alternate airports are presented.

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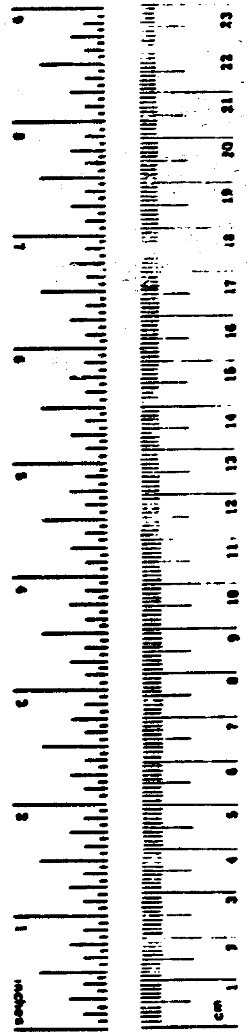
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

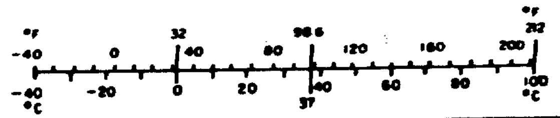
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this study effort was to examine methods of providing a data base of weather information pertinent to the requirements and qualifications for alternate airports.

1.2 BACKGROUND

Operations under Instrument Flight Rules (IFR) require the filing of a flight plan. The flight plan must contain an alternate airport unless certain conditions at the destination (the first airport of intended landing) are met. These conditions concern the availability of a standard instrument approach procedure and anticipated meteorological conditions within one hour of the estimated arrival time. If these conditions are not met, then an alternate airport is required in the flight plan.

There are also certain other conditions that must be met for an airport to qualify as an alternate. These conditions also deal with instrument approach availability and less stringent meteorological conditions. More detailed descriptions of the requirements and qualifications for alternate airports are contained in Section 1.4.

When an alternate airport is contained in the flight plan, the pilot must increase the aircraft fuel reserves to accommodate flight from the destination airport to the alternate and hold for 45 minutes. (Rotorcraft operating under Special Federal Aviation Regulation No. 29-3 may reduce the holding time to 30 minutes with FAA approval.) This requirement can have a profound effect upon mission reliability and mission delays for aircraft with limited range and endurance characteristics such as the helicopter. The requirement to file an alternate can create many situations in which a suitable alternate cannot be found within range of the aircraft capabilities. The flight must either be delayed until weather improves at the destination or the flight must be cancelled altogether.

A reduction in the meteorological constraints at the destination airport could therefore significantly improve the operational utility of IFR equipped helicopters. However, the reduction in meteorological requirements at the destination airport produces an increased risk of the destination weather being below approach minimums. This study effort investigates ways that this risk can be assessed through the study of climatological data pertaining to ceilings and visibilities.

1.3 SCOPE

This study effort was limited to the development of methods which relate climatological data to the operational problems associated with requirements and qualifications for alternate airports. Climatological data has been collected over a period of many years at many airports.

The first effort undertaken was to determine if these data were pertinent to the alternate airport problem and, if so, what methods of analysis could be applied to the data to produce results that could be interpreted in operational terms. Next, methods of limiting the amount of data processing necessary to produce these results through the application of statistical models were investigated. This effort did not include a sufficiently broad sample of results to permit validation of these statistical models.

Some data are presented for airports in several regions of the country. It should be cautioned that these data were obtained with an unvalidated model and although the results seem very reasonable and consistent, they should be considered only as examples of what types of data the methodology can produce and not as actual study results.

In summary, the products of the study are the interpretation of the climatological data in operational terms and development of the methods that were used to produce the operational interpretation. The actual processing of the meteorological data on a broad scale was not within the scope of this study.

1.4 CURRENT ALTERNATE AIRPORT CRITERIA

The current regulations concerning destination and alternate airport criteria as they typically apply to helicopters are found in the Federal Aviation Regulations (FAR's) Paragraphs 91.83 (General Aviation) and 135.217, 135.219, 135.221 and 135.223 (Air Taxi Operations).

The specific statements of these regulations are as follows:

<u>GENERAL AVIATION</u>

§91.83 Flight plan; information required.

(a) Information required. Unless otherwise authorized by ATC, each person filing an IFR or VFR flight plan shall include in it the following information:

•
•
•

(9) In the case of an IFR flight plan, an alternate airport, except, as provided in paragraph (b) of this section.

•
•
•

(b) Exceptions to applicability of paragraph (a)(9) of this section. Paragraph (a)(9) of this section does not apply if Part 97 of this subchapter prescribes a standard instrument approach procedure for the first airport of intended landing and, for at least one hour before and one hour after the estimated time of arrival, the weather reports or forecasts

or any combination of them, indicate --

(1) The ceiling will be at least 2,000 feet above the airport elevation; and

(2) Visibility will be at least 3 miles.

(c) IFR alternate airport weather minimums. Unless otherwise authorized by the Administrator, no person may include an alternate airport in an IFR flight plan unless current weather forecasts indicate that, at the estimated time of arrival at the alternate airport, the ceiling and visibility at that airport will be at or above the following alternate airport weather minimums:

(1) If an instrument approach procedure has been published in Part 97 of this chapter for that airport, the alternate airport minimums specified in that procedure or, if none are so specified, the following minimums:

(i) Precision approach procedure: Ceiling 600 feet and visibility 2 statute miles.

(ii) Nonprecision approach procedure: Ceiling 800 and visibility 2 statute miles.

(2) If no instrument approach procedure has been published in Part 97 of this chapter for that airport, the ceiling and visibility minimums are those allowing descent from the MEA, approach, and landing, under basic VFR.

AIR TAXI OPERATIONS

§135.217 IFR: takeoff limitations.

No person may takeoff an aircraft under IFR from an airport where weather conditions are at or above take off minimums but are below authorized IFR landing minimums unless there is an alternate airport within 1 hours's flying time (at normal cruising speed, in still air) of the airport of departure.

§135.219 IFR: destination airport weather minimums.

No person may take off an aircraft under IFR or begin an IFR or over-the-top operation unless the latest weather reports or forecasts, or any combination of them, indiate that weather conditions at the estimated time of arrival at the next airport of intended landing will be at or above authorized IFR landing minimums.

§135.221 IFR: alternate airport weather minimums.

No person may designate an alternate airport unless the weather reports or forecasts, or any combination of them, indicate that the weather conditions will be at or above authorized alternate airport landing minimums for that airport at the estimated time of arrival

§135.223 IFR: alternate airport requirements.

(a) Except as provided in paragraph (b) of this section, no person may operate an aircraft in IFR conditions unless it carries enough fuel (considering weather reports or forecasts or any combination of them) to-

(1) Complete the flight to the first airport of intended landing;

(2) Fly from that airport to the alternate airport; and

(3) Fly after that for 45 minutes at normal cruising speed.

(b) Paragraph (a)(2) of this section does not apply if Part 97 of this chapter prescribes a standard instrument approach procedure for the first airport of intended landing and, for at least one hour before and after the estimated time of arrival, the appropriate weather reports or forecasts, or any combination of them, indicate that-

(1) The ceiling will be at least 1,500 feet above the lowest circling approach MDA; or

(2) If a circling instrument approach is not authorized for the airport, the ceiling will be at least 1,500 feet above the lowest published minimum or 2,000 feet above the airport elevation, whichever is higher; and

(3) Visibility for that airport is forecast to be at least three miles, or two miles more that the lowest applicable visibility minimums, whichever is the greater, for the instrument approach procedure to be used at the destination airport.

In summary for paragraph 91.83 if a pilot can answer "yes" to the following two questions, then no alternate airport is required on the flight plan:

1) Does the destination have a standard instrument approach procedure?

2) Within one hour before and one hour after the estimated time of arrival, do the weather reports or forecasts for the destination indicate that the ceiling will be at least 2000 ft. above the airport elevation and the visibility at least 3 miles?

If either answer is "no", then an alternate airport must be filed in the flight plan.

Paragraph 135.223 is similar to paragraph 91.83 but it contains slightly more complex ceiling and visibility criteria for air taxi operators.

The qualifications for an alternate airport are found in paragraph 91.83(c). These qualifications depend upon the existence of an instrument approach procedure at the alternate and forecast or reported ceilings and visibilities at the estimated time of arrival.

If an airport has a published instrument approach procedure, then the ceilings and visibilities must exceed those published in the procedure; or if none are published, then ceilings and visibilities

must exceed 600 feet and 2 miles for precision approaches (ILS and PAR) or 800 feet and 2 miles for non-precision approaches (VOR, LOC, DME Arc, NDB, RNAV, ETC.).

If no instrument procedure is published, then ceiling and visibility minimums must permit descent from the Minimum Enroute Altitude, approach and landing under Visual Flight Rules.

SPECIAL FEDERAL AVIATION REGULATION No. 29-3;

LIMITED IFR OPERATIONS OF ROTORCRAFT

SFAR No. 29-3 allows for limited operations under IFR for certain rotorcraft which are certificated for operations under VFR. Paragraph 4 of SFAR No. 29-3 specifically applies to the fuel requirements for holding after reaching the alternate airport. This provision relaxes the holding time requirement from 45 minutes to 30 minutes for qualifying rotorcraft.

> *4. Notwithstanding § 91.23(a)(3) of the Federal Aviation Regulations, a person may operate a rotorcraft in a limited IFR operation approved under paragraph 2(a) of this Special Federal Aviation Regulation with enough fuel to fly, after reaching the alternate airport, for not less than 30 minutes, when that period of time has been approved.*
>
> *This Special Federal Aviation Regulation terminates on December 31, 1982, unless sooner superseded or rescinded.*

1.5 PROPOSED ALTERNATE AIRPORT CRITERIA

There were proposals, made by the helicopter industry at the recent Regulatory Review, to change alternate airport requirements to 1000 feet ceiling and 1 mile visibility. This same proposal considered changing alternate airport qualifications to 300 feet and 1 statute mile for precision approach procedures and 600 feet and 1 statute mile for nonprecision approach procedures.

In summary, the current and proposed requirements for the need to file an alternate airport in the IFR flight plan for helicopters are presented in Table 1.1. The current and proposed qualifications for alternate airports for helicopters are presented in Table 1.2.

Table 1.1 Current and Proposed IFR Alternate Airport Requirements For Helicopters

	Ceiling(ETA ± 1 hr)	Visibility (ETA ± 1 hr)
Current Requirements, Part 91	2000 ft	3 miles
Current Requirements, Part 135*	Circling MDA +1500 ft	2 miles + IAP Requirement
Proposed Requirements	1000 ft	1 mile

Note: The table assumes the destination has a published Instrument Approach Procedure (IAP)

*If Part 91 requirements exceed Part 135 requirements, then Part 91 requirements shall be used.

Table 1.2 Current and Proposed Alternate Airport Qualifications For Helicopters*

	Ceiling (ETA)	Visibility (ETA)
Current Requirements, Precision Approach	600 ft	2 miles
Current Requirements, Non-Precision Approach	800 ft	2 miles
Proposed Requirements, Precision Approach	300 ft	1 mile
Proposed Requirements, Non-Precision Approach	600 ft	1 mile

*Requirements apply unless superceded by non standard or restricted alternate minimums published in the airport instrument approach procedure.

2.0 METHOD OF APPROACH

Dr. Donald E. Martin of Saint Louis University (SLU) in Report AFGL-TR-78-0308 "Climatic Models That Will Provide Timely Mission Success Indicators for Planning and Supporting Weather Sensitive Operations", (Reference 1) and in other reports, developed statistical methods based on present observed conditions to aid in forecasting for various time increments and/or for space increments.

It appeared that similar methods would have application as a basis for setting alternate minimum regulations by establishing a statistical deterioration rate of visibility and ceiling.

It is necessary to develop a statistically valid data base of weather deterioration probabilities prior to making modifications in the destination or alternate destination weather minimums. The methods used by Dr. Martin and the Saint Louis University would seem to provide a procedure for developing the data base. Therefore these methods form the basis for this study program.

The basis for the weather analyses are the conditional probability equations numbers (16) and (17) contained on page 20 of Reference 1. These equations are as follows:

$$P(2|1) = r^2 + (1.00 - r^2)\,P_2 \qquad \text{when } P_1 <= P_2 \qquad (16)$$

and

$$P(2|1) = r^2 \frac{P_2}{P_1} + (1.00 - r^2)\,P_2 \qquad \text{wnen } P_1 > P_2 \qquad (17)$$

The term $P(2|1)$ may be interpreted as meaning "The probability that Event 2 occurs given that Event 1 occurs".

As an example in operational terms related to this program, the term $P2|1)$ was interpreted as follows:

"Given that the current ceiling is greater than 3000 feet, what is the probability that the ceiling will be less than or equal to 500 feet in 3 hours".

The P_1 and P_2 terms in the equations refer to unconditional probabilities for Events 1 and 2. In the operational example they are interpreted as follows:

P_1 is the probability that the current ceiling is greater than 3000 ft.

P_2 is the probability that the ceiling will be less than or equal to 500 ft. in 3 hours.

The remaining term in the equations is the r^2 parameter developed by Dr. Martin. This term can be thought of as a correlation term relating the conditional probability $P(2|1)$ and the unconditional probability P_2.

For example:

If Event 2 always occurs when Event 1 occurs, then the conditional probability $P(2|1)$ would be unity. This is obviously true in Equation (16) when $r^2 = 1$ which represents a one to one correlation.

If Event 1 and Event 2 are uncorrelated, then it would be expected that $r^2 = 0$. In this instance $P(2|1) = P_2$ by either Equation (16) or (17). This also is the anticipated result for $P(2|1)$.

The main appeal of Equations (16) and (17) is that this analytical model provides a means for determining conditional probability tables from only unconditional probabilities and a table of r^2 values. The model can therefore be used to provide conditional probabilities at stations where no conditional data exists. The model is also useful in reducing the amount of source data and data processing required to analyze weather probabilities at airports that have conditional probability data. The challenge is, of course, to determine and validate the r^2 values.

2.1 DATA SOURCES

2.1.1 Conditional Probability Data

The computation of r^2 values uses raw climatology data like that shown in Figure 2.1 and 2.2 for Fairchild AFB, Washington. These data, called persistence-probability tables, are actually conditional probability tables of the following form:

$P(C_N = X|C_o = Y)$ or $P(V_N = U|V_o = W)$

Stated in textual terms this means:

The probability that the ceiling is in Category X in N hours (C_N) given that the initial ceiling (C_O) is in Category Y: and,

The probability that the visibility is in Category U in N hours (V_N) given that the initial visibility (V_o) is in Category W.

The ceiling categories shown in Figure 2.1 are:

A: <200'
B: 200' - 499'
C: 500' - 999'
D: 1000' - 2999'
E: 3000' - 9999'
F: $\geq$10000

The visibility categories correspond to:

J: <0.5 mi
K: 0.5 mi but <1.0 mi
L: 1.0 mi but <2.0 mi
M: 2.0 mi but <3.0 mi
N: 3.0 mi but <6.0 mi
O: $\geq$6.0 mi

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 00-01 LST

CEILING CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	70	51	43	40	39	41	20	12	6	9	20	10	13
	B	16	28	39	37	32	24	33	29	24	13	15	23	15
	C	2	5	5	7	10	12	9	13	10	17	6	12	1
	D	2	6	5	4	2	5	10	11	13	6	12	15	15
	E	7	6	5	9	13	11	10	11	18	23	23	13	23
	F	2	4	4	4	4	6	20	23	28	32	24	27	30
	OBS	82	82	82	82	82	82	82	82	82	82	82	82	82
B	A	7	9	10	9	10	10	6	5	8	5	7	3	6
	B	75	64	58	54	49	48	36	25	21	30	32	21	20
	C	10	13	16	18	18	17	19	25	18	11	13	17	11
	D	3	7	8	7	8	9	12	12	11	10	7	12	12
	E	3	5	5	7	9	8	13	15	14	16	14	20	18
	F	2	3	3	5	6	8	14	18	28	28	27	27	33
	OBS	273	273	273	273	273	273	273	273	273	273	273	273	273
C	A	1	3	3	5	7	7	3	1	2	2	6	3	6
	B	18	24	24	22	24	24	21	17	15	14	18	8	16
	C	66	51	44	38	30	27	23	20	13	17	17	17	12
	D	9	12	14	19	20	19	17	21	18	11	8	18	12
	E	3	3	7	10	11	12	18	20	20	18	17	22	22
	F	2	5	7	7	8	10	18	20	32	38	35	32	31
	OBS	205	205	205	205	205	205	205	205	205	205	205	205	205
D	A	1	4	5	6	5	5	4	2	1	3	2	0	4
	B	5	8	10	12	17	17	21	14	10	16	13	15	18
	C	13	15	18	24	22	19	18	15	13	13	14	14	14
	D	66	52	41	30	27	27	18	25	24	16	17	17	9
	E	11	13	17	17	16	19	18	19	20	16	23	22	19
	F	4	7	8	11	13	12	20	25	31	35	31	32	35
	OBS	195	195	195	195	195	195	195	195	195	195	195	195	195
E	A	0	0	1	1	3	1	2	0	1	3	3	1	3
	B	4	7	7	7	8	9	9	6	5	8	12	10	12
	C	3	6	8	10	12	12	16	14	8	10	9	11	10
	D	9	11	12	12	13	13	16	19	17	13	12	15	9
	E	75	60	53	49	42	43	28	26	30	26	26	21	26
	F	9	16	19	21	22	21	30	35	39	41	37	41	41
	OBS	387	387	387	387	387	387	387	387	387	387	387	387	387
F	A	1	1	1	2	3	3	2	1	1	2	3	1	3
	B	2	3	5	7	8	10	8	6	5	8	9	8	13
	C	1	2	2	2	3	3	7	7	7	8	9	12	12
	D	1	1	2	2	2	4	7	9	10	9	9	14	9
	E	6	10	13	15	16	17	17	19	21	21	20	18	18
	F	90	83	77	72	68	64	60	58	55	52	50	47	46
	OBS	718	718	718	718	718	718	718	718	718	718	718	718	718

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	4.4	14.7	11.0	10.5	20.8	38.6
TOTAL OBS	1860	82	273	205	195	387	718

Figure 2.1 Ceiling Conditional Probability Tables for Fairchild AFB, Washington

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 00-01 LST
WIND SECTOR ALL

VISIBILITY CATEGORY INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
						HOURS SUBSEQUENT								
J	J	78	62	55	47	47	48	37	22	16	22	28	14	18
	K	12	17	16	17	16	12	12	5	9	6	8	10	6
	L	4	6	7	8	8	9	13	14	8	8	11	13	9
	M	2	4	2	3	3	2	3	3	6	4	3	3	3
	N	1	3	7	5	5	6	8	20	18	16	3	16	8
	O	2	8	14	19	22	22	27	35	43	44	47	43	57
	OBS	172	172	172	172	172	172	172	172	172	172	172	172	172
K	J	23	25	20	23	20	23	19	12	12	13	19	13	19
	K	47	42	38	27	29	26	14	9	8	8	12	2	12
	L	15	13	16	18	19	20	16	16	12	11	5	13	4
	M	3	2	4	8	10	3	7	11	9	3	3	9	5
	N	3	8	7	8	9	9	19	18	19	18	9	11	9
	O	5	10	14	16	14	19	25	34	41	47	51	52	51
	OBS	91	91	91	91	91	91	91	91	91	91	91	91	91
L	J	7	8	8	13	19	16	20	10	9	10	18	7	16
	K	16	19	23	17	13	14	14	13	7	8	12	5	7
	L	53	42	33	25	22	22	14	13	14	19	9	12	13
	M	13	7	5	10	6	5	4	4	2	4	3	4	2
	N	6	12	13	11	12	13	20	18	18	4	6	12	7
	O	5	13	17	24	29	29	28	42	50	55	53	60	55
	OBS	112	112	112	112	112	112	112	112	112	112	112	112	112
M	J	3	3	5	3	5	7	12	7	7	3	7	3	10
	K	5	8	5	10	20	20	20	8	3	2	7	7	10
	L	17	22	18	17	13	15	8	17	8	18	5	8	5
	M	45	30	18	8	5	8	5	10	8	8	8	7	3
	N	13	18	25	28	20	20	27	27	22	8	15	13	2
	O	17	18	28	33	37	30	28	32	52	60	58	62	70
	OBS	60	60	60	60	60	60	60	60	60	60	60	60	60
N	J	0	2	7	10	10	10	7	4	5	7	10	4	13
	K	5	9	7	7	8	12	13	5	5	6	6	1	3
	L	13	15	13	13	12	11	18	10	6	10	9	13	10
	M	8	8	4	4	6	5	11	4	4	2	5	2	4
	N	44	36	32	20	17	12	11	21	16	11	10	19	7
	O	30	30	38	46	48	51	40	56	63	65	60	60	63
	OBS	136	136	136	136	136	136	136	136	136	136	136	136	136
O	J	1	2	3	4	4	4	4	2	2	3	5	3	6
	K	0	2	3	2	3	4	5	3	3	2	3	4	4
	L	1	2	2	3	4	4	6	5	5	5	5	6	5
	M	1	1	1	1	1	2	3	3	2	3	3	3	3
	N	4	5	5	6	6	7	11	9	9	9	7	12	7
	O	93	88	85	83	81	78	71	77	80	79	76	71	74
	OBS	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	9.2	4.9	6.0	3.2	7.3	69.3
TOTAL OBS	1860	172	91	112	60	136	1289

Figure 2.2 Visibility Conditional Probability Tables for Fairchild AFB, Washington

The data in Figure 2.1 and 2.2 are interpreted as follows:

In Figure 2.1 the letters in the far left under the column labeled INIT correspond to the initial ceiling category. The next column, labeled SUBS corresponds to the category observed at the subsequent time. Subsequent time categories, ranging from 1 hour to 48 hours, are shown in the first row across the page.

Going down the first column the numbers mean:

Given the initial ceiling is in Category A, the probability that the ceiling is in Category A one hour later is 70%.

Given the initial ceiling is in Category A, the probability that the ceiling is in Category B one hour later is 16%.

And going down a few lines:

Given the initial ceiling is in Category B, the probability that the ceiling is in Category A one hour later is 7%.

And for later times:

Given the initial ceiling is in Category C, the probability that the ceiling is in Category B four hours later is 22%.

Visibility tables in Figure 2.2 are analogous to the ceiling tables.

Given the initial visibility is in Category L, the probability that the visibility is in Category J three hours later is 8%.

The terms OBS at the end of each initial category is the number of observations from which the data were collected.

At the bottom of Figures 2.1 and 2.2, the numbers of observations for each initial category are again shown along with the percentages for each initial category. These values are the unconditional probabilities of ceilings (visibilities) being in each category. For example, the probability of the ceiling being in Category B at Fairchild AFB in January during 00-01 Local Standard Time is 14.7%.

The month, local time, and years in which the data were collected are shown in the upper right hand legends of the figures. These data represent one, two-hour time period for one month. In order to obtain a complete set of persistence-probability tables such as those shown, it takes 144 pages of ceiling data and 144 pages of visibility data for each station.

Obviously the r^2 model developed by Dr. Martin in Reference 1 could considerably reduce the amount of data sources and data processing necessary to produce data that is pertinent to the alternate airport problem. The r^2 model requires only the use of unconditional probabilities

and r^2 table values. Sources of unconditional probability data are described in the following paragraphs. Construction methods for the r^2 tables are described in Section 2.2.

2.1.2 Unconditional Probability Data

One source of unconditional probability data is the summary lines at the bottom of the conditional probability data as depicted in Figures 2.1 and 2.2.

Another source is Appendix C in Reference 1. Data in this document is presented in a compacted form as shown in Figures 2.3 for Fairchild AFB, Washington. In this form the entire unconditional ceiling and visibility data for a single station can be presented on a single page. The data are interpreted as follows:

Data for each month of the year are presented as a series of twelve, nine or ten digit strings of numbers. The first six strings are ceiling data and the last six strings are visibility data.

The categories for ceilings and visibilities correspond to cumulative categories rather than specific categories. That is, the first row corresponds to ceilings in categories A and B; the second row corresponds to ceilings in A, B and C; the third row corresponds to ceilings in A, B, C and D; and so on.

The visibility data is also in a cumulative format.

In order to understand the data string it is necessary to understand the manner in which it is packed. For example the string corresponding to ceilings less than 500 ft for December is 478865566:

	MULT	0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	TIME PERIOD
<500 ft	4	7	8	8	6	5	5	6	6	PACKED PROBABILITY

The right eight digits correspond to eight, three-hour time periods during the day in terms of local standard time on the 24 hour clock. The left digit (or occasionally two digits) is a multiplier to be applied to each hourly digit in the string. Thus the unpacked unconditional probabilities are:

	0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-24	TIME PERIOD
<500 ft	28%	32%	32%	24%	20%	20%	24%	24%	PROBABILITY

These values thus become a very convenient way for reducing the complexity of the unconditional probability data source. Some resolution

FAIRCHILD AB WA SKA WMO NUMBER = 727855

LAT = 47.6 LON = 117.7 E (METERS) = 750.0 E/EBAR = 1.1

	DEC	JAN	FEB
< 500 FT	478865566	378864466	288763356
< 1000 FT	578877677	489986677	377875555
< 3000 FT	688888777	677877666	478887666
< 5000 FT	778888777	689988778	578877666
< 10000 FT	888888888	888888777	688988777
< 20000 FT	988888887	988888877	788998887
< .5 MI	277764446	245543234	244531123
< 1 MI	377764456	345653334	266752245
< 3 MI	478886566	466775555	366764345
< 5 MI	577886566	566776555	456764444
< 6 MI	578887666	567887666	467874455

	MAR	APR	MAY
< 500 FT	136732224	112210000	111210000
< 1000 FT	245652333	135752112	134631112
< 3000 FT	346787544	234575322	233565322
< 5000 FT	456679755	433468532	422357422
< 10000 FT	656778755	645558744	545568754
< 20000 FT	766778866	755668765	656678765
< .5 MI	122310011	101100000	100000000
< 1 MI	124521112	101200000	101100000
< 3 MI	223531222	111310000	101100000
< 5 MI	234642333	113431110	112211110
< 6 MI	245753333	124642211	112321110

	JUN	JUL	AUG
< 500 FT	111100000	100000000	111100000
< 1000 FT	123421111	100100000	111211100
< 3000 FT	145885323	101111100	112343111
< 5000 FT	323366322	111145311	123468421
< 10000 FT	544567643	234457633	245679744
< 20000 FT	656668754	346567654	357889855
< .5 MI	101000000	100000000	100100000
< 1 MI	101000000	100000000	100100000
< 3 MI	101000000	100000000	100100000
< 5 MI	112100110	101000000	111110111
< 6 MI	112211110	101000000	111111111

	SEP	OCT	NOV
< 500 FT	100100000	146851123	356753344
< 1000 FT	112221111	235652223	467765445
< 3000 FT	123354322	256897445	489998667
< 5000 FT	222335322	356777544	588888767
< 10000 FT	345657654	477888766	689998888
< 20000 FT	456767765	666877766	877888777
< .5 MI	100100000	135730011	255631223
< 1 MI	100100000	136840012	267853344
< 3 MI	100210100	224631112	367864445
< 5 MI	101211110	235862222	456864444
< 6 MI	101322210	334752222	467975545

Figure 2.3 Packed Unconditional Probability Data
(Source: Appendix C, Reference 1)

is obviously sacrificed in the data packing process. The impact of this loss of resolution on the overall products of the study program was not considered but is an area that warrants further analysis.

2.2 DEVELOPMENT OF THE r^2 PARAMETER

The computation of the table of r^2 values is achieved by using the following procedure:

1. Solve Equations (16) and (17) from Reference 1 for r^2 and retain the constraints on the unconditional probabilities.

$$r^2 = \frac{P(2|1) - P_2}{1 - P_2} \quad \text{for } P_1 \leq P_2$$

$$r^2 = \frac{P(2|1) - P_2}{P_2(1/P_1 - 1)} \quad \text{for } P_1 > P_2$$

2. Utilizing conditional and unconditional probabilities from data tables like those shown in Figures 2.1 and 2.2 determine r^2 values.

3. Accumulate values for r^2 from several time periods, several months of the year, and from several geographical areas. Combine these r^2 values by finding the statistical mean value. The resultant values become the composite r^2 tables.

4. Validate the r^2 model by:

   a) Examining the variation in the r^2 values that are used to determine the composite r^2 values.

   b) Utilize the composite r^2 values to compute the conditional probabilities from whence the original r^2 values were derived. Compare the original and computed conditional probabilities and evaluate the fidelity of the model.

5. Utilize the composite r^2 tables and compacted unconditional probability data described in Section 2.1.2 and determine conditional probability values for several locations that are operationally significant for civil helicopter operations.

6. Compare actual conditional probability data and data developed from the model. Ascertain the validity of the model. Consider alternative models or procedures if the r^2 model is not appropriate for the alternate airport problem.

Steps 1-4 were carried out in conjunction with a graduate research program at Saint Louis University. In this program r^2 values were developed for sixteen weather stations in four geographical areas of the country. These areas and stations are:

Northeast

- Westover, Massachusetts
- McGuire, New Jersey
- Dover, Delaware
- Pease, New Hampshire

North Central

- Ellsworth, South Dakota
- Offutt, Nebraska
- Cinker, Oklahoma
- Minot, North Dakota

Southeast

- Robbins, Georgia
- Blytheville, Arkansas
- Little Rock, Arkansas
- Randolph, Texas

West

- March, California
- Fairchild, Washington
- Yakima, Washington
- Gray, Washington

The locations of these weather stations used by Saint Louis University are shown in Figure 2.4.

Steps five and six were performed by the contractor. Utilizing the r^2 values generated by the Saint Louis University program and the compacted unconditional probability data from Reference 1, conditional probabilities values were computed for time periods of one hour, three hours and six hours after the initial time period. Conditional probability data from Fairchild Air Force Base in Washington were obtained and compared with conditional probabilities for Fairchild developed from the r^2 model.

The results of this comparison and the subsequent development of alternate formulations for the r^2 parameters are discussed in Section 3.

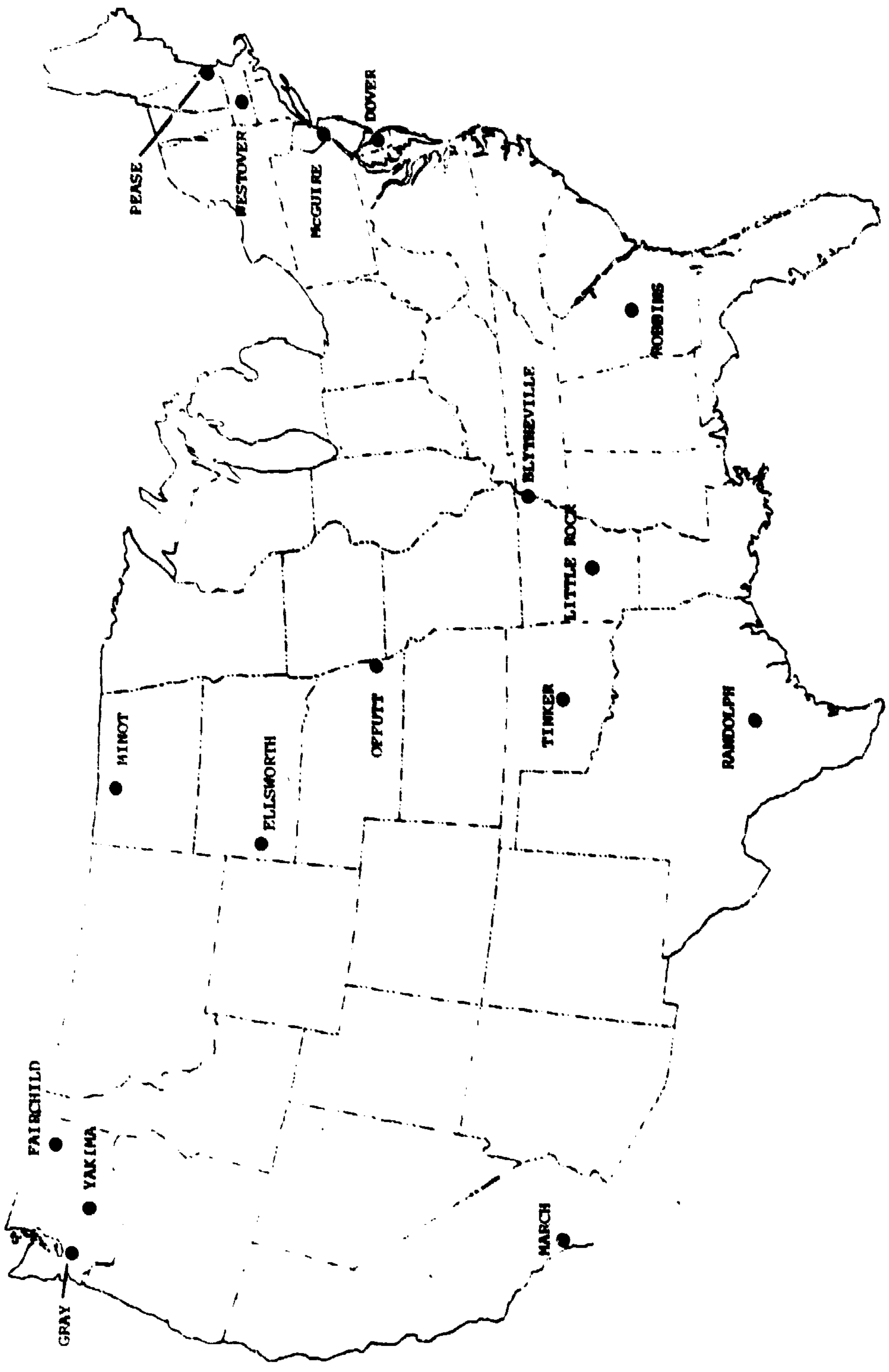

Figure 2.4 Weather Stations Used in the SLU Analysis

DISCUSSION

The study results are presented in three parts. 3.1 contains an analysis of the interpretation of the climatology in terms that are operationally significant for the alternate airport problem. 3.2 describes the development and use of the cumulative probability model. 3.3 describes the results that were obtained through the application of the cumulative probability model.

3.1 OPERATIONAL CLIMATOLOGY PARAMETERS

3.1.1 Ceilings

In reviewing the climatology information contained in the persistency-probability tables, the following observations were made concerning the ceiling categories:

1. The 200 and 500 ft ceiling categories are roughly equivalent to ILS Category I ceiling minimums and non-precision approach respectively.

2. The 500 ft ceiling category is close to the 600 ft ceiling that qualifies an airport with a precision approach capability as an alternate airport.

3. The 1000 ft ceiling category is close to the 800 ft ceiling that qualifies an airport with a non-precision approach capability as an alternate airport.

4. The 1000 ft ceiling also represents a goal that the helicopter operators have for requiring the filing of an alternate airport in the flight plan.

5. The 3000 ft ceiling category is slightly greater than the current ceiling requirement of 2000 ft for filing an alternate airport in the flight plan.

6. Ceiling data in the compacted unconditional probability tables in Reference 1 have the following altitude boundaries: 500 ft, 1000 ft, 3000 ft, 5000 ft, 10,000 ft and 20,000 ft. Ceiling data in the persistency probability tables have the following altitude boundaries: 200 ft, 500 ft, 1000 ft, 3000 ft, and 10,000 ft. Altitudes which are common in the two data bases are: 500 ft, 1000 ft, 3000 ft and 10,000 ft.

   Since data was not available for the 200 ft category from both sources, the 500 and 1000 ft categories were selected to represent precision and non-precision approach minimum respectively. This assumption means the results are conservative. Actual risk probabilities for ceiling would be less than those in this analysis.

With these considerations, the following six ceiling parameters were selected as being the most relevant to the alternate airport problem:

1. The probability that the ceiling N hours later will be less than 500 ft given the initial ceiling is greater than or equal to 1000 ft.

   $P(C_N < 500 \text{ ft} \mid C_0 \geq 1000)$

2. The probability that the ceiling N hours later will be less than 500 ft given the initial ceiling is greater than or equal to 3000 ft.

   $P(C_N < 500 \text{ ft} \mid C_0 \geq 3000)$

3. The unconditional probability that the ceiling will be less than 500 feet.

   $P(C < 500)$

4. The probability that the ceiling N hours later will be less than 1000 ft given the initial ceiling is greater than or equal to 1000 ft.

   $P(C_N < 1000 \mid C_0 \geq 1000)$

5. The probability that the ceiling N hours later will be less than 1000 ft given the initial ceiling is greater than or equal to 3000 ft.

   $P(C_N < 1000 \mid C_0 \geq 3000)$

6. The unconditional probability that the ceiling will be less than 1000 ft.

   $P(C < 1000)$

These six ceiling parameters have roughly the following operational conotations:

1. The probability that the ceiling will be less than precision approach minimums under the regulation proposed by the helicopter operators.
2. The probability that the ceiling will be less than precision approach minimums under the current regulation.
3. The probability that the ceiling will be less than precision approach minimums.
4. The probability that the ceiling will be less than non-precision approach minimums under the regulation proposed by the helicopter operators.
5. The probability that the ceiling will be less than non-precision approach minimums under the current regulation.
6. The probability that the ceiling will be less than non-precision approach minimums.

For comparison purposes these parameters break down into two sets of three parameters:

The difference between ceiling parameters 1 and 2 is the increased risk in terms of the ceiling being below precision approach minimums due to reducing alternate airport requirements from current values to those desired by the helicopter operators.

Comparison of ceiling parameters 1 and 2 with 3 indicates the amount of improvement in predicting ceilings below precision approach minimums when ceiling information is known at the initial time versus no knowledge of initial ceiling information.

The difference between ceiling parameters 4 and 5 is the increased risk in terms of the ceiling below non-precision approach minimums due to reducing alternate airport requirements from current values to those desired by helicopter operators.

Comparison of ceiling parameters 4 and 5 with 6 indicates the amount of improvement in predicting ceilings below non-precision approach minimums when ceiling information is known at the initial time versus no knowledge of initial ceiling information.

3.1.2 Visibilities

The visibility categories contained in the persistency-probability tables are related to operational visibility parameters in the following way:

1. The 0.5 mi visibility category is roughly equivalent to ILS Category I minimums for fixed-wing aircraft and non-precision approach visibility minimums for helicopters.
2. The 1.0 mi visibility category is the goal that helicopter operators have for requiring the filing of an alternate airport in the flight plan.
3. The 1.0 mi visibility category is roughly equivalent to the visibility requirement for slower fixed-wing aircraft. Almost all instrument approaches can be made with a visibility of 1.0 mile with helicopters.
4. The 2.0 mi visibility category is equivalent to the visibility that qualifies airports with precision and non-precision approach procedures to be used as alternate airports.
5. The 3.0 mi visibility category is equivalent to the current visibility requirement for filing an alternate airport in the IFR flight plan.

In utilizing visibility data from both the persistency-probability tables and the compacted unconditional probability tables in Reference 1, the following visibility boundaries are common to both data sources: 0.5 mi, 1.0 mi, 3.0 mi and 6.0 mi.

Based upon these observations, the following six visibility parameters were selected as being the most relevant to the alternate airport problem:

1. The probability that the visibility N hours later will be less than 0.5 mile given the initial visibility is greater than or equal to 1.0 mile.

   $P(V_N < 0.5 \mid V_0 \geq 1.0)$
2. The probability that the visibility N hours later will be less than 0.5 mile given the initial visibility is greater than or equal to 3.0 miles.

   $P(V_N < 0.5 \mid V_0 \geq 3.0)$
3. The unconditional probability that the visibility will be less than 0.5 mile.

   $P(V < 0.5)$

4. The probability that the visibility N hours later will be less than 1.0 mile given the initial visibility is greater than or equal to 1.0 mile.

   $P(V_N < 1.0 \mid V_0 \geq 1.0)$

5. The probability that the visibility N hours later will be less than 1.0 mile given the initial visibility is greater than or equal to 3.0 miles.

   $P(V_N < 1.0 \mid V_N \geq 3.0)$

6. The unconditional probability that the visibility will be less than 1.0 mile.

   $P(V < 1.0)$

These six visibility parameters have roughly the following operational conotations:

1. The probability that the visibility will be less than precision approach minimums under the regulation proposed by the helicopter operators.
2. The probability that the visibility will be less than precision approach minimums under the current regulation.
3. The probability that the visibility will be less than precision approach minimums.
4. The probability that the visibility will be less than non-precision approach minimums under the regulation proposed by the helicopter operators.
5. The probability that the visibility will be less than non-precision approach minimums under the current regulation.
6. The probability that the visibility will be less than non-precision approach minimums.

Similar to the ceiling parameters, the visibility parameters break down into two sets of three parameters:

The difference between visibility parameters 1 and 2 is the increased risk in terms of the visibility being below precision approach minimums due to reducing alternate airport requirements from current values to those desired by the helicopter operators.

Comparison of visibility parameters 1 and 2 with 3 indicates the amount of improvement in predicting visibilities below precision approach minimums when visibility information is known at the initial time versus no knowledge of initial visibility information.

The differences between visibility parameters 4 and 5 is the increased risk in terms of the visibility being below non-precision approach minimums due to reducing alternate airport requirements

from current values to those desired by helicopter operators.

Comparison of visibility parameters 4 and 5 with 6 indicates the amount of improvement in predicting visibilities below non-precision approach minimums when visibility information is known at the initial time versus no knowledge of initial visibility information.

3.1.3 Time Period Variations

Several of the selected operational parameters have a time period specification between some initial time and a subsequent time. In operational terms the initial time corresponds to the time that the latest ceiling and visibility measurements were reported; and the subsequent time refers to the estimated arrival time at the airport. The time span between the initial time and the subsequent time is equivalent to the age of the ceiling and visibility report plus the aircraft flight time.

Three time periods were utilized in the study, one, three, and six hours. The one hour period corresponds to many helicopter operations which are one hour or less in duration. The three hour time period corresponds to many fixed-wing operations and an upper limit for helicopter flights. The six-hour time period is a typical upper limit for fixed-wing operations. The one, three, and six-hour periods provide a reasonably broad spectrum of time periods in which to evaluate ceiling and visibility characteristics.

Four ceiling parameters and four visibility parameters are affected by the time period between the initial time and the subsequent time. These values are the conditional probabilities. Evaluating these parameters at three time periods produced a total of twelve visibility values. The remaining two ceiling parameters and two visibility parameters are the unconditional probabilities. These values are not affected by the period between the initial time and the subsequent time. In total there were fourteen ceiling values and fourteen visibility values produced for each airport used in the analysis, or twenty-eight data values in all.

3.1.4 Averaging of Monthly and Daily Variations

The computational procedures for the ceiling and visibility parameters produced data that had both hourly and monthly variations. The source data is available for each month in both the packed unconditional probability tables and the persistency-probability tables. The former data source had hourly data for eight, three-hour time periods and the latter source has hourly data for twelve, two-hour time periods.

In order to reduce the amount of tabular output data, the monthly and hourly data were averaged. The statistical mean value was taken as the output of the probability analysis. This procedure reduced the amount of output from any one station from 2688 values to 28 values in

the packed unconditional probability cases and from 4032 values to 28 values in the persistence-probability case.

3.2 THE r^2 MATRIX

3.2.1 Development of the Cumulative r^2 Tables

Matricies of composite r^2 values were originally applied to ceiling and visibility parameters by researchers at Saint Louis University. Unfortunately, models using these matricies proved to be unreliable for ceilings and visibilities with a low probability of occurence. Methods of reducing the variation in the r^2 values when low probability situations were encountered were examined. The most promising method was the use of cumulative probabilities rather than the category probabilities shown in Figures 2.1 and 2.2. The main drawback in this formulation of the problem was that the data in the persistency-probability tables had to be reprocessed to a considerable extent. These procedures are outlined in Appendix A.

A very limited amount of data and contract resources were available to develop and utilize the cumulative r^2 tables. Only a limited amount of persistency-probability data had been obtained to check the model developed by SLU. This data, shown in Appendix B, was for Fairchild AFB, Washington for the month of January.

It was decided to utilize this limited data to develop the cumulative r^2 procedure. Then, if this data looked satisfactory, validate the procedure using unconditional probability data for Fairchild in January. This obviously is not a completely satisfactory validation of the model as geographical and seasonal universality is not tested. These tasks remain to be completed.

The methods described in Appendix A were applied to the data contained in Appendix B and cumulative r^2 tables for Fairchild were developed. Table 3.1 contains the cumulative r^2 values corresponding to ceiling data and Table 3.2 contains cumulative r^2 values corresponding to visibility data.

These cumulative r^2 values have correlation function characteristics as was anticipated in Section 2.0. In no instances were negative r^2 values obtained. Also small differences between the initial time and and the subsequent time produce r^2 values close to unity indicating high correlation. As the time interval is increased, the cumulative r^2 values decrease indicating a reduction in correlation. These results are reasonable when considering the correlation characteristic attributed to the r^2 parameter.

3.2.2 Validation of the Cumulative r^2 Tables

In developing the cumulative r^2 values, the cumulative conditional probabilities were developed as part of the procedure. These values are

Table 3.1 Cumulative r^2 Value for Ceilings (Values Multiplied by 100)

SUBSEQUENT TIME

INITIAL TIME	<=A	<=B	<=C	<=D	<=E	DIFFERENCE
	74.28	88.35	91.71	93.25	92.55	1 HOUR
<=A	49.82	72.60	78.06	82.87	84.72	3 HOURS
	33.64	52.78	61.56	68.98	73.16	6 HOURS
	89.23	79.79	88.81	92.45	93.80	1 HOUR
<=B	71.96	62.10	74.07	81.64	86.06	3 HOURS
	52.07	47.94	57.78	67.07	74.07	6 HOURS
	91.42	87.90	84.61	89.36	91.98	1 HOUR
<=C	77.53	71.56	69.02	76.04	81.66	3 HOURS
	60.56	55.00	53.54	59.77	67.72	6 HOURS
	91.54	90.66	89.98	85.12	90.09	1 HOUR
<=D	81.03	77.26	75.59	71.02	78.20	3 HOURS
	64.00	61.40	59.00	56.77	62.88	6 HOURS
	91.63	91.56	92.90	92.37	85.12	1 HOUR
<=E	83.12	81.05	82.47	81.47	69.43	3 HOURS
	62.78	65.60	68.41	66.26	53.97	6 HOURS

Table 3.2 Cumulative r^2 Values for Visibility (Values Multiplied by 100)

SUBSEQUENT TIME

INITIAL TIME	<=A	<=B	<=C	<=D	<=E	DIFFERENCE
	75.22	84.37	91.14	92.73	96.36	1 HOUR
<=A	57.00	63.64	72.05	76.39	84.70	3 HOURS
	43.82	44.56	53.57	56.87	67.19	6 HOURS
	84.72	75.82	85.25	88.05	94.55	1 HOUR
<=B	61.78	56.58	64.76	69.79	80.00	3 HOURS
	45.96	41.90	46.38	50.11	60.87	6 HOURS
	91.11	84.71	79.17	82.38	92.13	1 HOUR
<=C	69.67	63.47	60.57	64.22	75.63	3 HOURS
	55.85	45.38	44.62	48.16	57.27	6 HOURS
	92.46	87.51	81.98	80.81	90.15	1 HOUR
<=D	72.47	67.67	61.70	62.95	72.96	3 HOURS
	58.44	49.30	45.21	48.04	55.82	6 HOURS
	95.64	93.30	90.99	88.32	82.50	1 HOUR
<=E	79.07	76.35	72.47	70.20	66.65	3 HOURS
	66.33	59.10	54.79	52.76	52.46	6 HOURS

interpreted as follows:

$$P(C_N \leq \text{Cat } i \mid C_0 < \text{Cat } j) \text{ and}$$
$$P(V_N \leq \text{Cat } k \mid V_0 < \text{Cat } 1)$$

The pr..ability that the ceiling N hours later will be less than or equal to Category i when the initial ceiling is less than or equal to Category j; and the probability that the visibility N hours later will be less than or equal to Category k given the initial visibility is less than or equal to Category 1. An example of this data is shown in Table 3.3.

The symbols in the left hand column refer to the cumulative categories at the initial time. The symbols across the top row refer to the cumulative categories at the subsequent time. The first table is for a one hour elapsed time between the initial and subsequent time. The second and third tables are for three and six hour periods. Examples of these data are:

The probability that the ceiling in one hour will be less than or equal to Category B given the initial category was less than or equal to Category C is 59.6%.

The probability that the ceiling in three hours will be less than or equal to Category C given the initial category was less than or equal to Category A is 87.0%.

Corresponding values for these conditional probabilities were computed utilizing the unconditional probabilities and the derived tables of r^2 values. An example is shown in Table 3.4. The format of this data is equivalent to that of Table 3.3.

These values were calculated for each of the twelve periods and for each of the 25 possible ceiling and visibility categories for elapsed times between the initial and subsequent times of one, three, and six hours. Differences between the actual data and that derived from the r^2 tables were computed. The results of this comparison are shown in the histograms of Figure 3.1 through 3.6.

The histograms indicate that in most cases the difference between the actual data and the derived conditional probability data was less than 5 % and in the majority of the cases the differences were less than one or two percent. The histograms also show that the model is more accurate for short periods between the initial and subsequent times than for the longer elapsed times. The model appears to work about equally well for ceiling and visibility.

Utilizing this validation information and the fact that the r^2 tables had reasonable correlation characteristics, it was decided to accept the validity of the cumulative r^2 tables until a more thorough evaluation of geographical and seasonal effects was available.

Table 3.3 Conditional Probabilities for Ceilings in January Fairchild AFB, 00-01 Local Standard Time

(Values in Percent)

	INITIAL TIME	SUBSEQUENT TIME <=A	<=B	<=C	<=D	<=E
1 HOUR	<=A	70.0	86.0	88.0	90.0	97.0
	<=B	21.5	82.9	91.1	93.8	97.8
	<=C	14.0	59.6	88.9	93.9	97.5
	<=D	10.7	45.7	70.8	91.6	97.1
	<=E	7.0	31.6	49.2	66.0	95.0
3 HOURS	<=A	43.0	82.0	87.0	92.0	97.0
	<=B	17.6	71.2	84.7	92.0	97.0
	<=C	12.3	55.1	79.7	89.4	95.2
	<=D	10.4	44.7	67.6	85.4	94.1
	<=E	7.2	32.3	50.1	66.0	89.7
6 HOURS	<=A	41.0	65.0	77.0	82.0	93.0
	<=B	17.1	59.6	75.5	83.5	92.2
	<=C	13.4	49.2	69.1	81.1	91.0
	<=D	11.3	42.1	61.8	77.7	90.0
	<=E	7.8	31.2	48.3	63.3	85.9

Table 3.4 Derived Conditional Probabilities for Ceilings in January, Fairchild AFB, 00-01 Local Standard Time

(Values in Percent)

	INITIAL TIME	SUBSEQUENT TIME <=A	<=B	<=C	<=D	<=E
1 HOUR	<=A	75.5	90.7	94.3	96.1	97.2
	<=B	22.5	83.9	92.4	95.7	97.7
	<=C	14.7	62.5	89.5	93.9	97.0
	<=D	11.0	47.8	73.5	91.4	96.3
	<=E	7.4	32.4	50.3	67.1	94.4
3 HOURS	<=A	52.2	78.7	85.5	90.5	94.5
	<=B	19.5	70.5	82.9	89.8	95.0
	<=C	13.5	58.9	79.5	86.7	93.4
	<=D	10.5	47.1	71.3	83.9	92.1
	<=E	7.3	33.4	51.4	67.1	89.0
6 HOURS	<=A	37.6	64.2	75.3	83.4	91.2
	<=B	19.0	60.5	72.9	82.4	91.5
	<=C	14.3	55.1	70.2	78.5	89.4
	<=D	11.5	45.9	66.3	76.9	87.8
	<=E	8.3	34.2	51.3	66.0	84.8

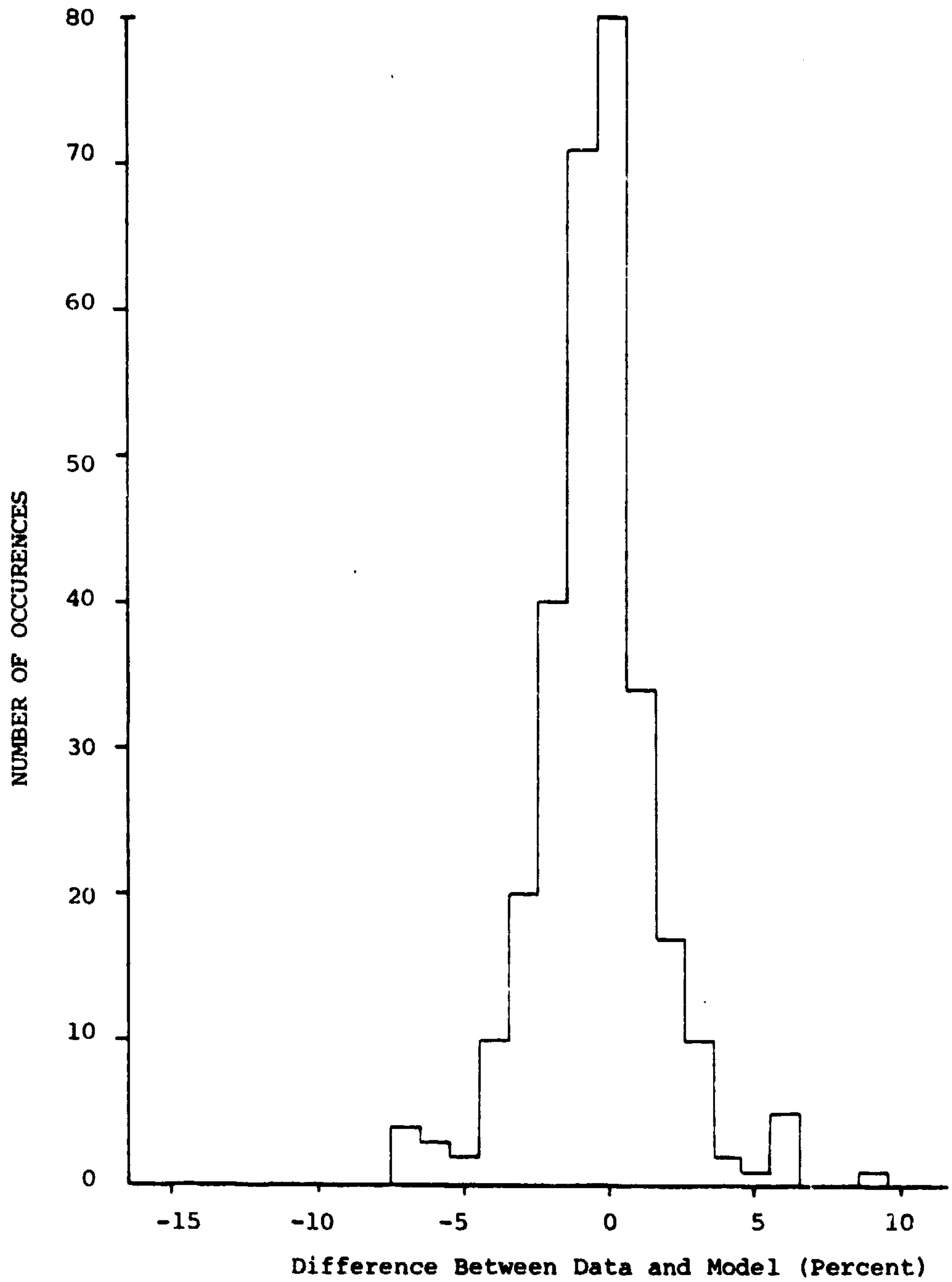

Figure 3.1 Histogram of r^2 Model Fidelity For Ceiling - One Hour Delay

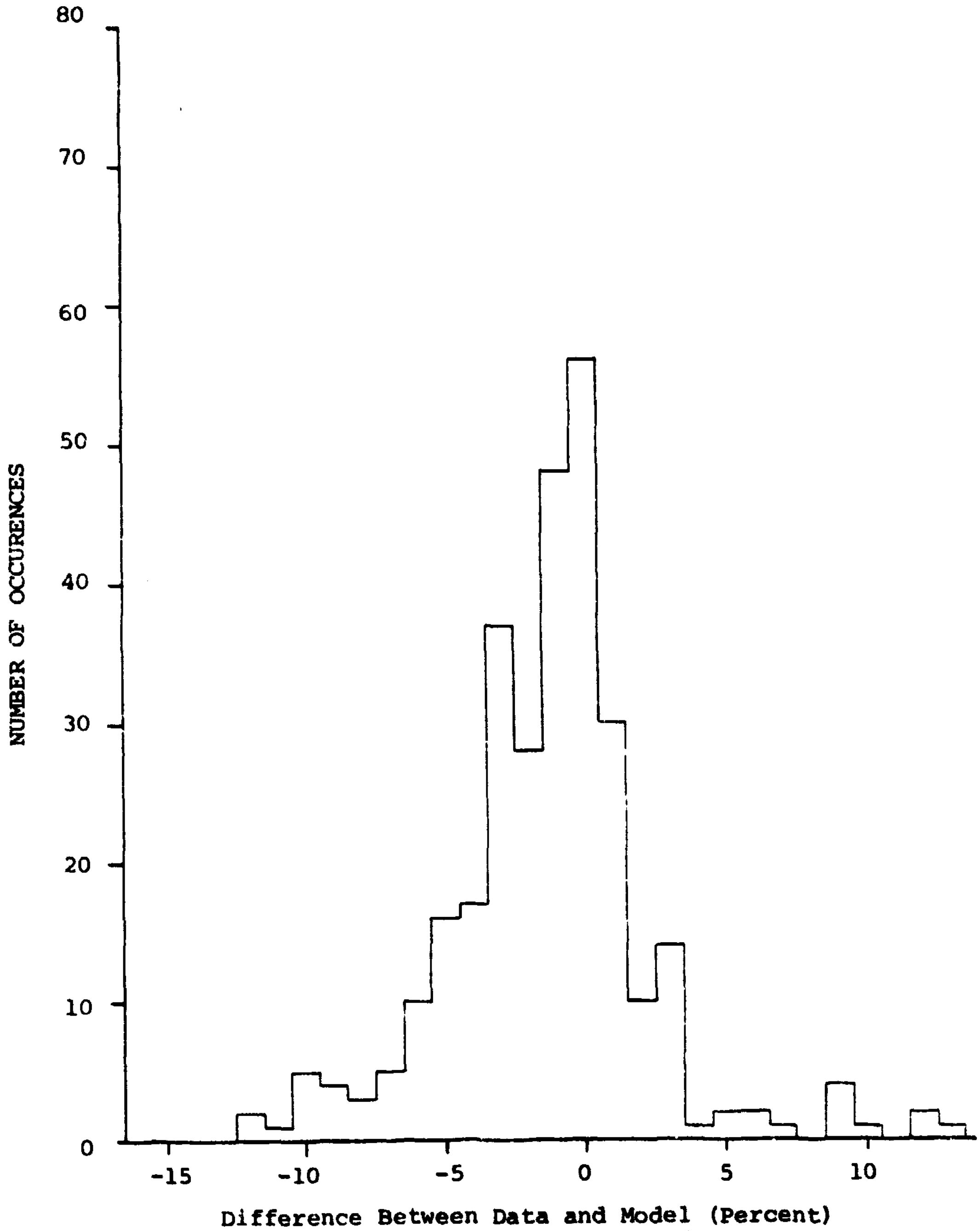

Figure 3.2 Histogram of r^2 Model Fidelity for Ceiling - Three Hour Delay

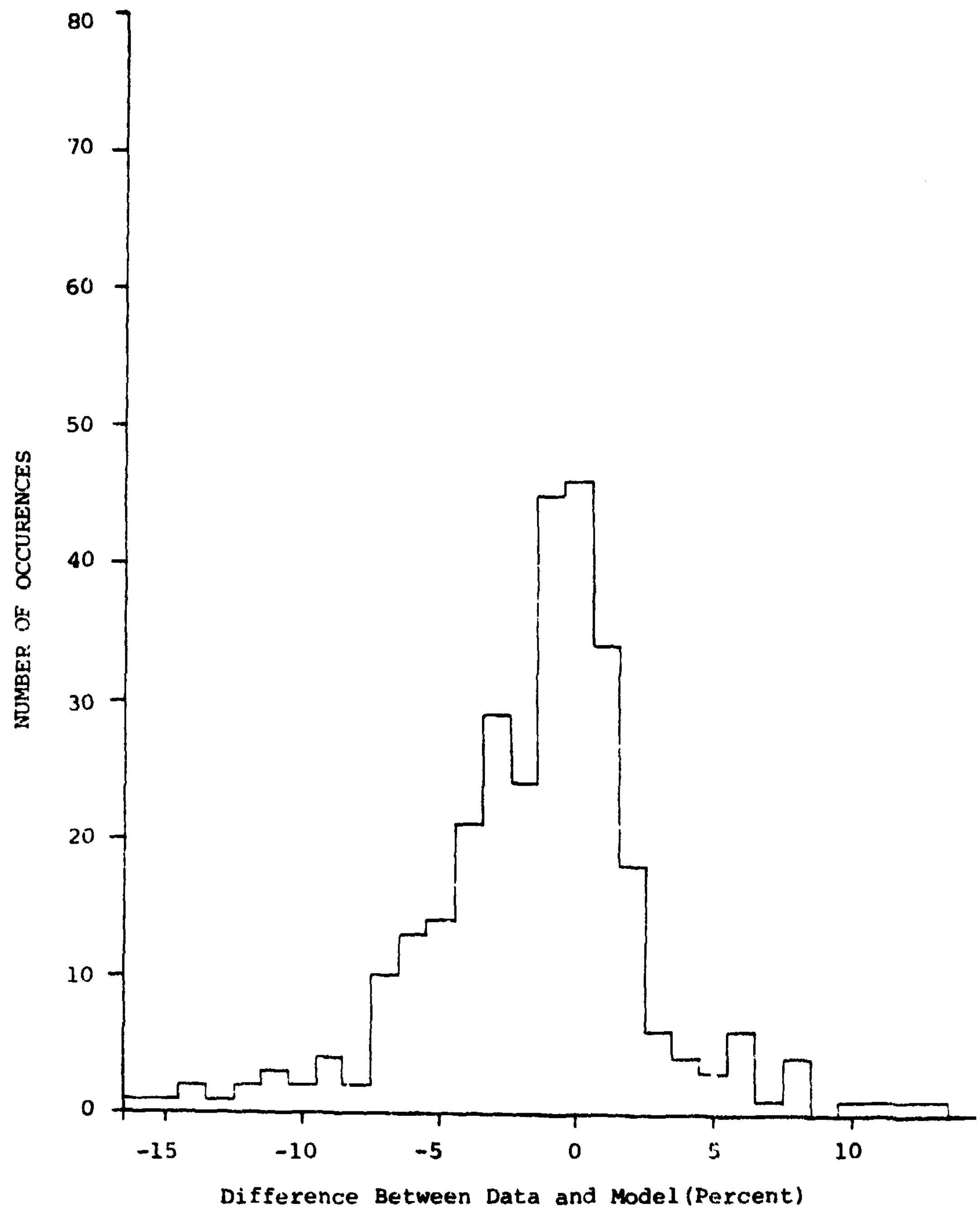

Figure 3.3 Histogram of r^2 Model Fidelity for Ceiling - Six Hour Delay

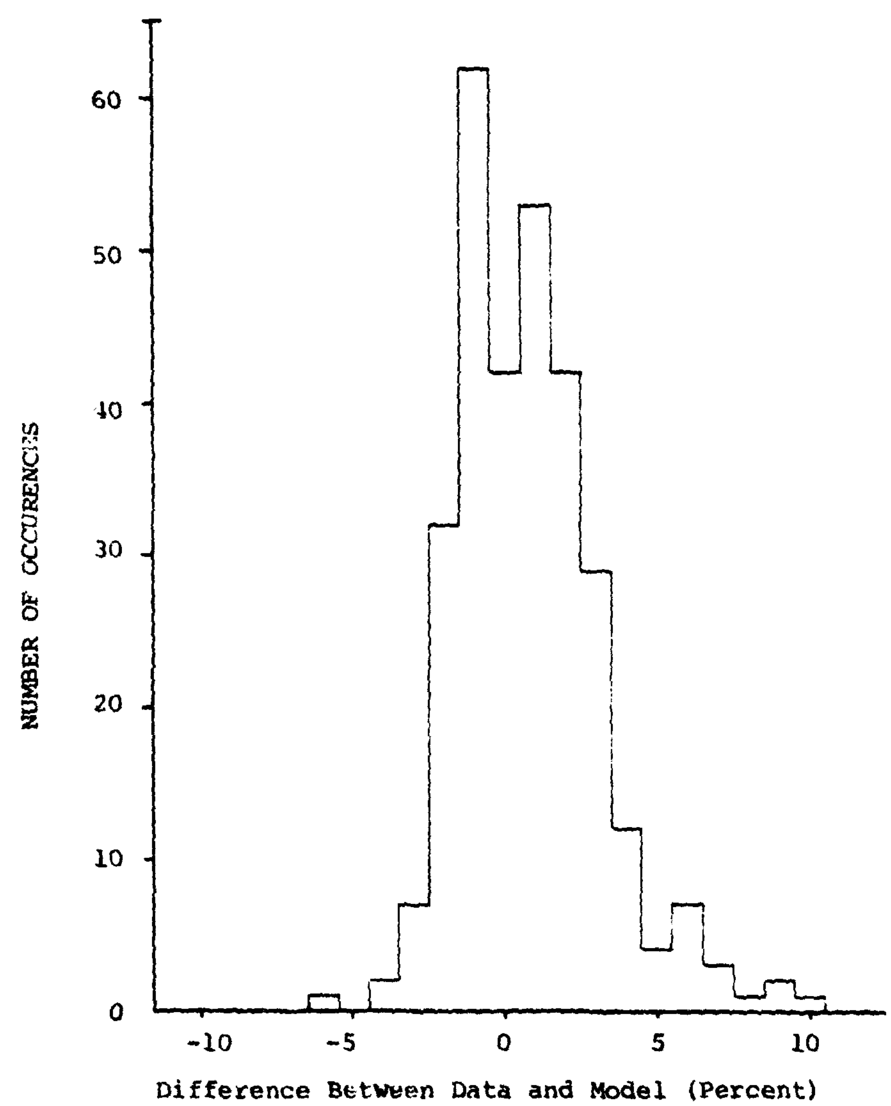

Figure 3.4 Histogram of r^2 Model Fidelity for Visibility - One Hour Delay

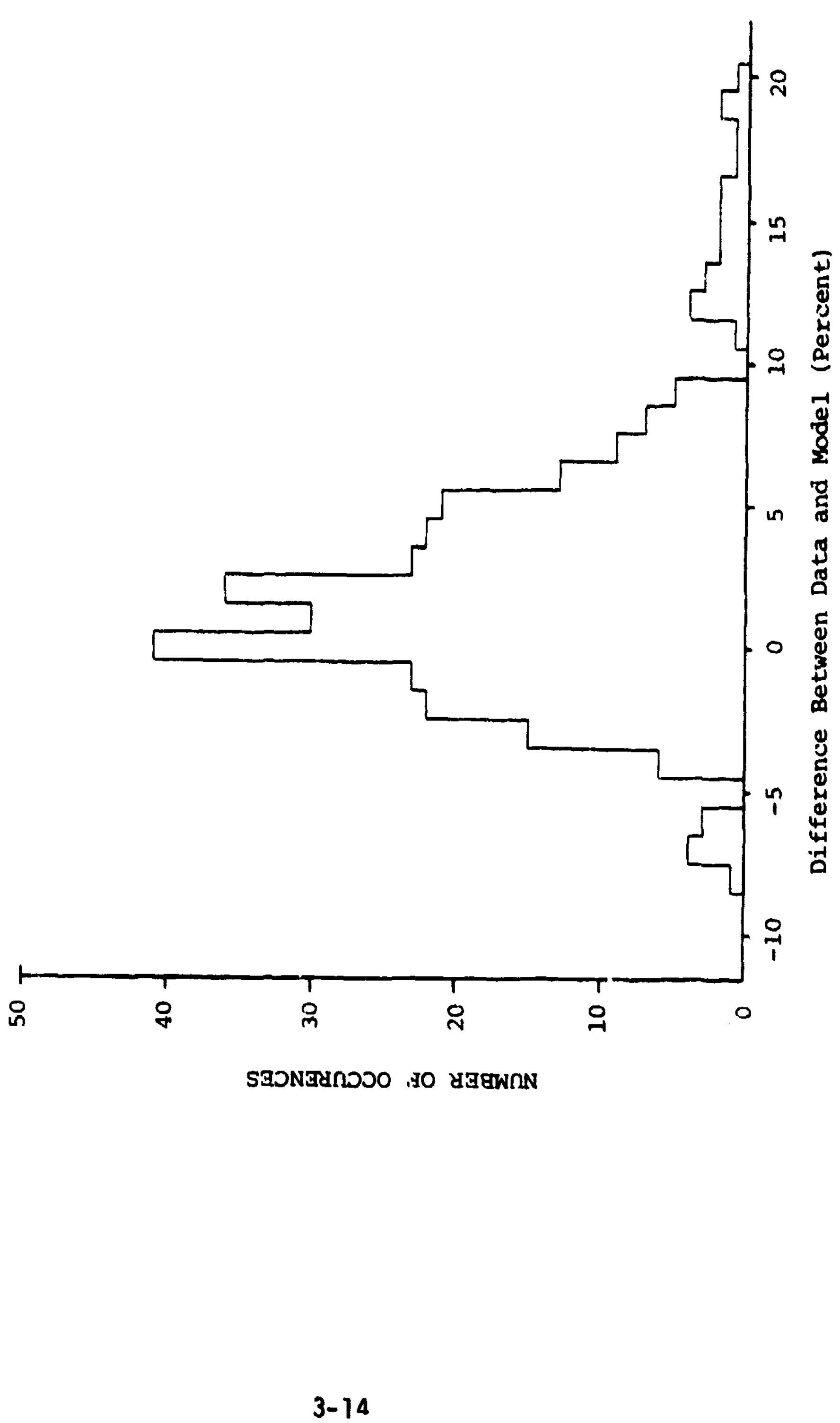

Figure 3.5 Histogram of r^2 Model Fidelity For Visibility - Three Hour Delay

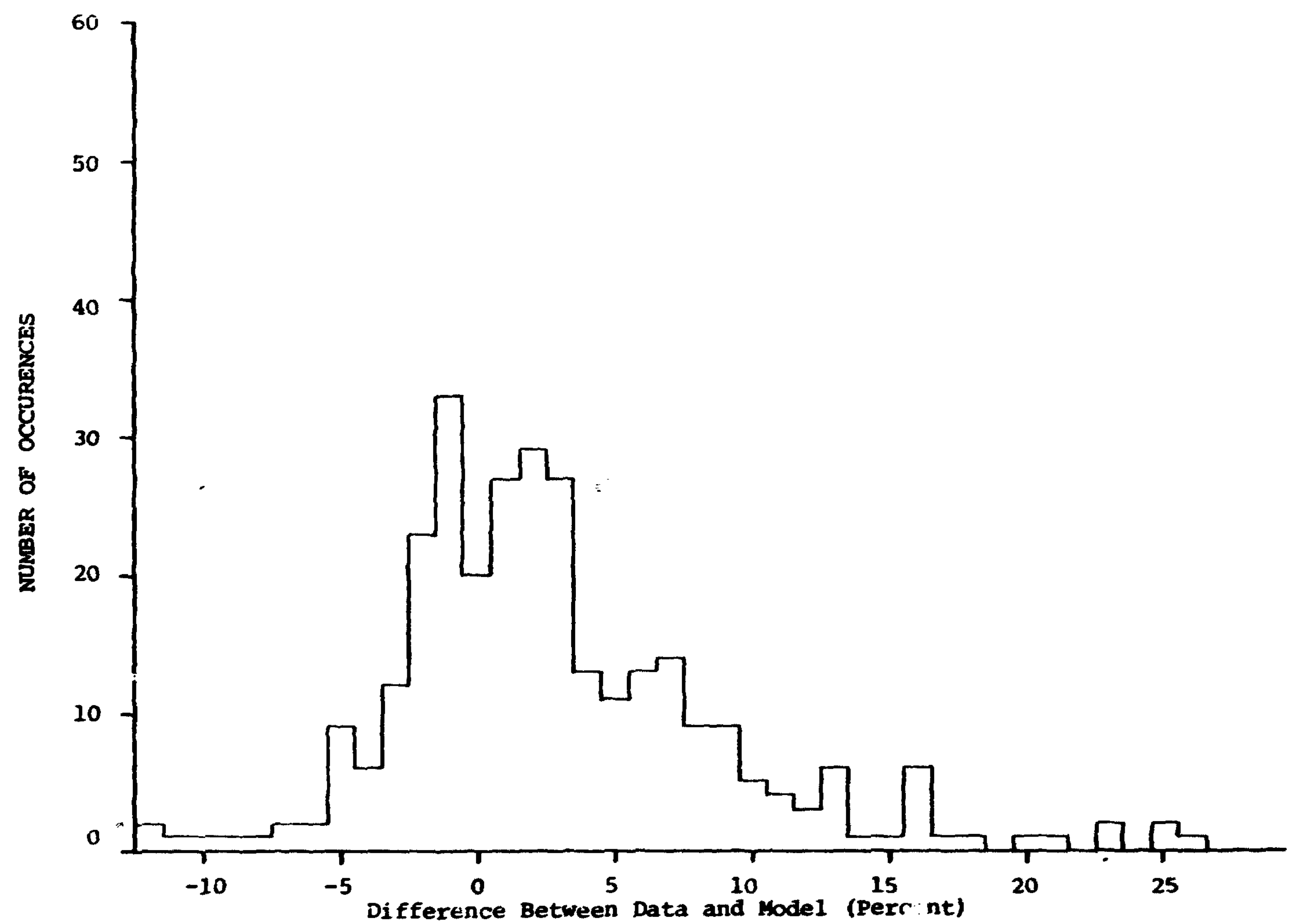

Figure 3.6 Histogram of r^2 Model Fidelity for Visibility - Six Hour Delay

3.3 APPLICATION OF THE CUMULATIVE r^2 MODEL

3.3.1 Development of the Operational Parameters

The cumulative r^2 model is capable of developing conditional probabilities of the type described in Section 3.3.2. These values must be processed further to yield the operational parameters described in Sections 3.1.1 and 3.1.2. The derivation of this relationship is presented in Appendix C. The relationship uses cumulative conditional probabilities and cumulative unconditional probabilities.

3.3.2 Selection of Representative Weather Stations

The cumulative r^2 model was used to determine conditional probabilities that were to be used in the relationship of Appendix C to develop operational parameters relevant to the alternate airport problem.

From the large set of weather station data in Reference 1, twenty-five were chosen for determining operational parameters. About half of the stations were chosen on the basis of their locations being near known active helicopter operational areas: East Coast, Gulf Coast, West Coast and Appalachian Areas. The remaining stations were chosen to give a balanced geographical representation of the operational areas. A map of the twenty-five station locations is shown in Figure 3.7.

3.3.3 Analysis of the Operational Parameters

The twenty-eight operational parameters discussed in Section 3.1.1 and 3.1.2 were computed for each of the twenty-five weather stations. The results are presented in tabular form in Appendix D and are presented graphically in Figures 3.8 - 3.12. In the figures the cities are presented in order of increasing percentage of ceilings below 1000 ft. The lines connecting the city data are of no significance other than to aid in the graphical presentation of the data. The shaded areas in the graphs indicate a consistent pattern of slightly increased risks of low ceilings and visibilities in going from current alternate airport requirements to the reduced requirements desired by the helicopter operators.

The graphs also indicate significantly increased chances of low ceilings and visibilities occuring if the time duration between the initial time and subsequent time (which can be interpreted as the age of the weather report at the destination plus the flight time) is large. Generally the occurence of low ceilings and visibilities for a one hour period using regulations proposed by the helicopter operators carries less risk than a three hour time period under current regulations. This result would tend to indicate that a relaxation of the alternate airport requirements for short duration flights would carry about the same risk of low ceilings and visibilities as longer flights under current regulations. Thus a sliding scale of increasing alternate airport requirements with increasing flight duration would tend to even the risk factor associated with ceilings and visibilities lowering to values less than approach minimums.

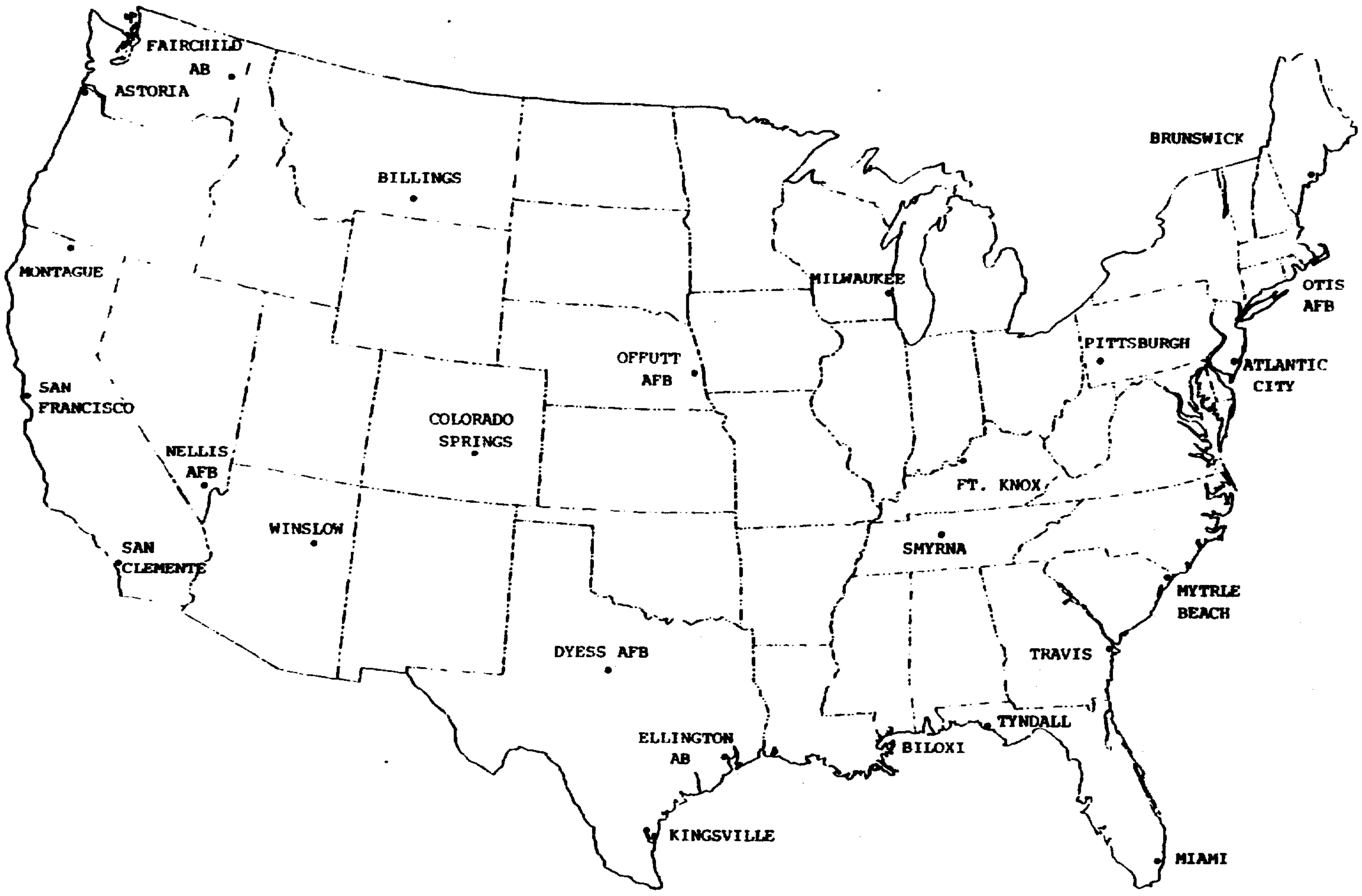

Figure 3.7 Weather Stations Used in the Operational Parameter Analysis

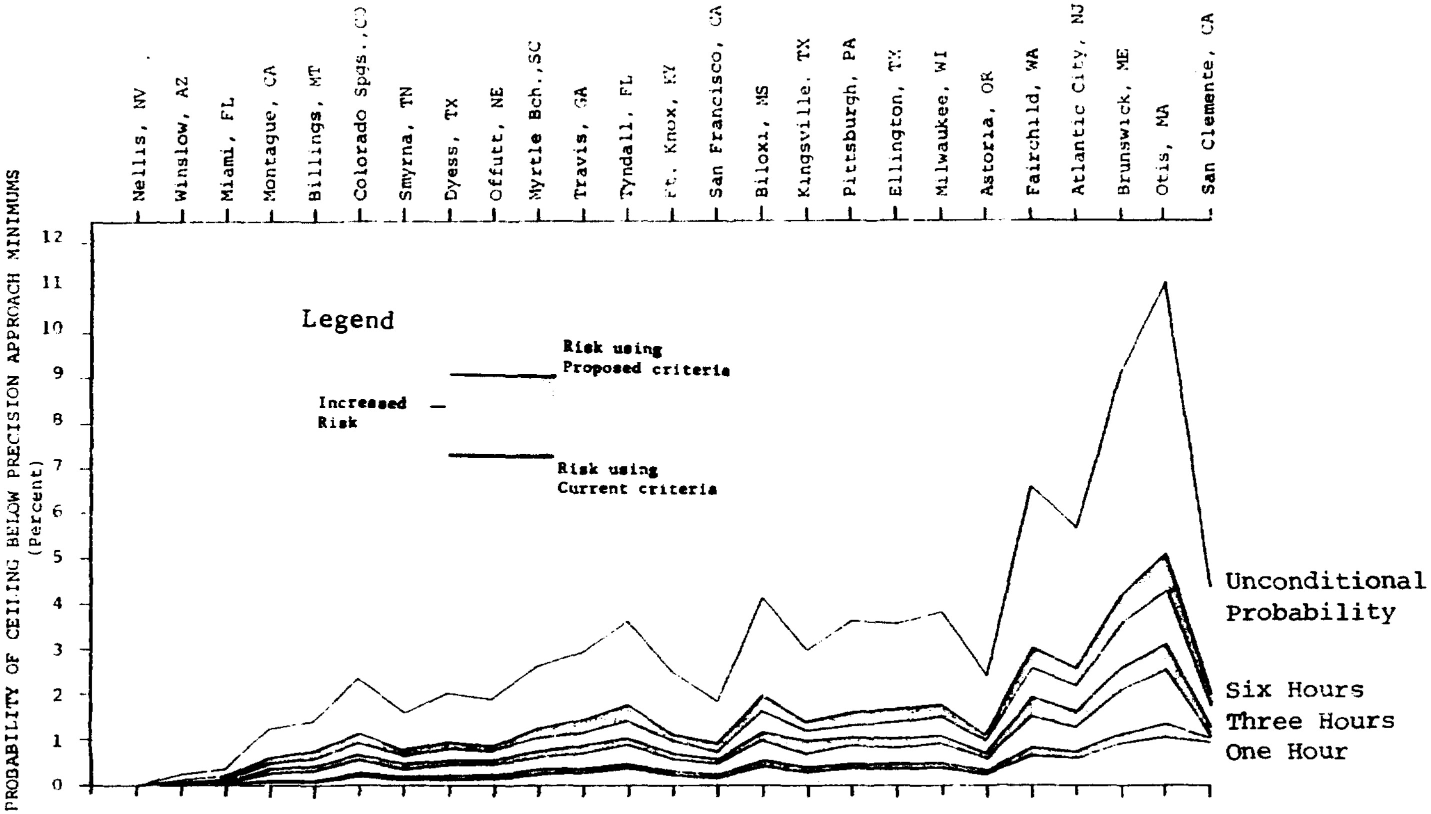

Figure 3.8 Risk For Ceilings Below Precision Approach Minimums

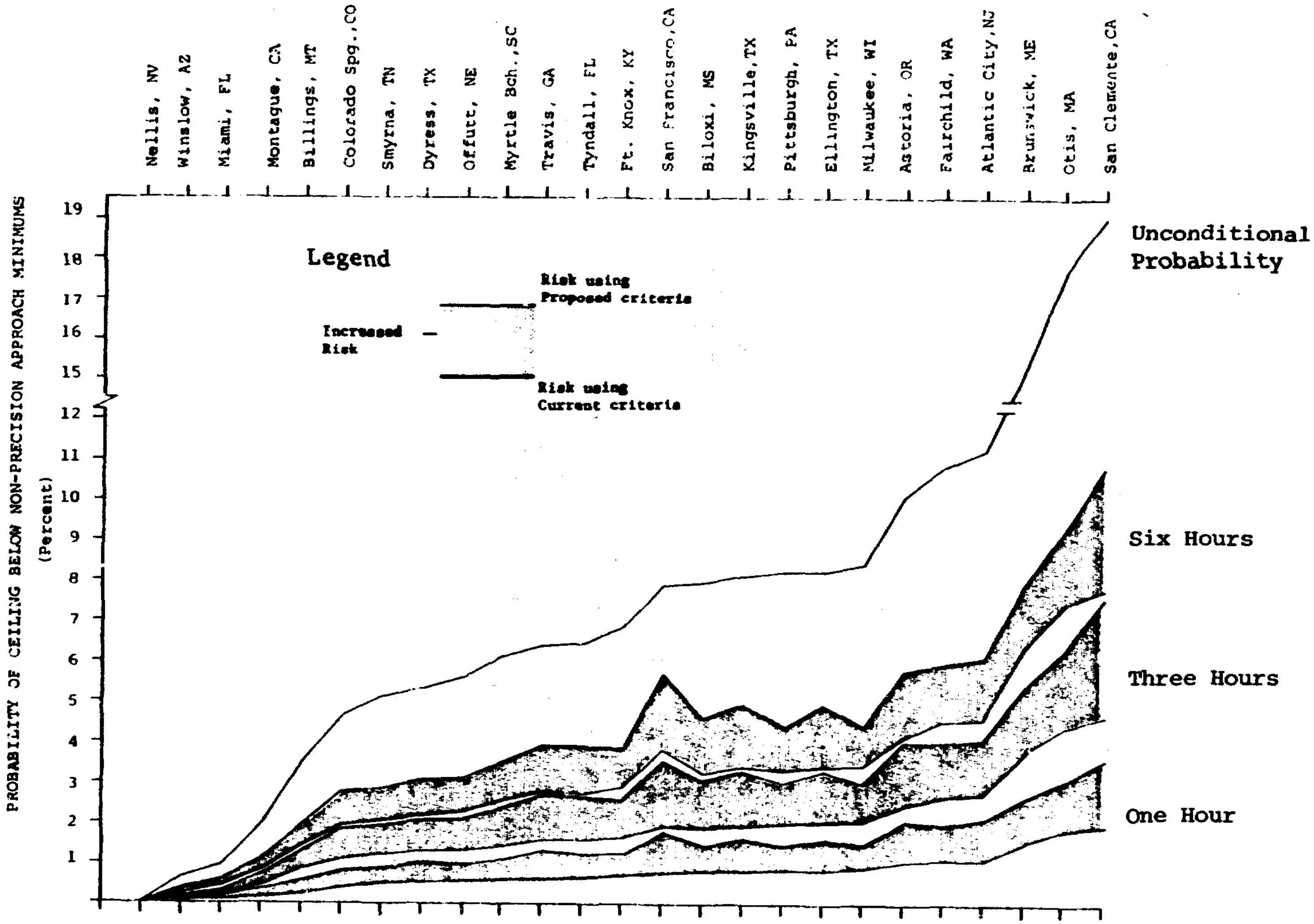

Figure 3.9 Risk for Ceilings Below Non-Precision Approach Minimums

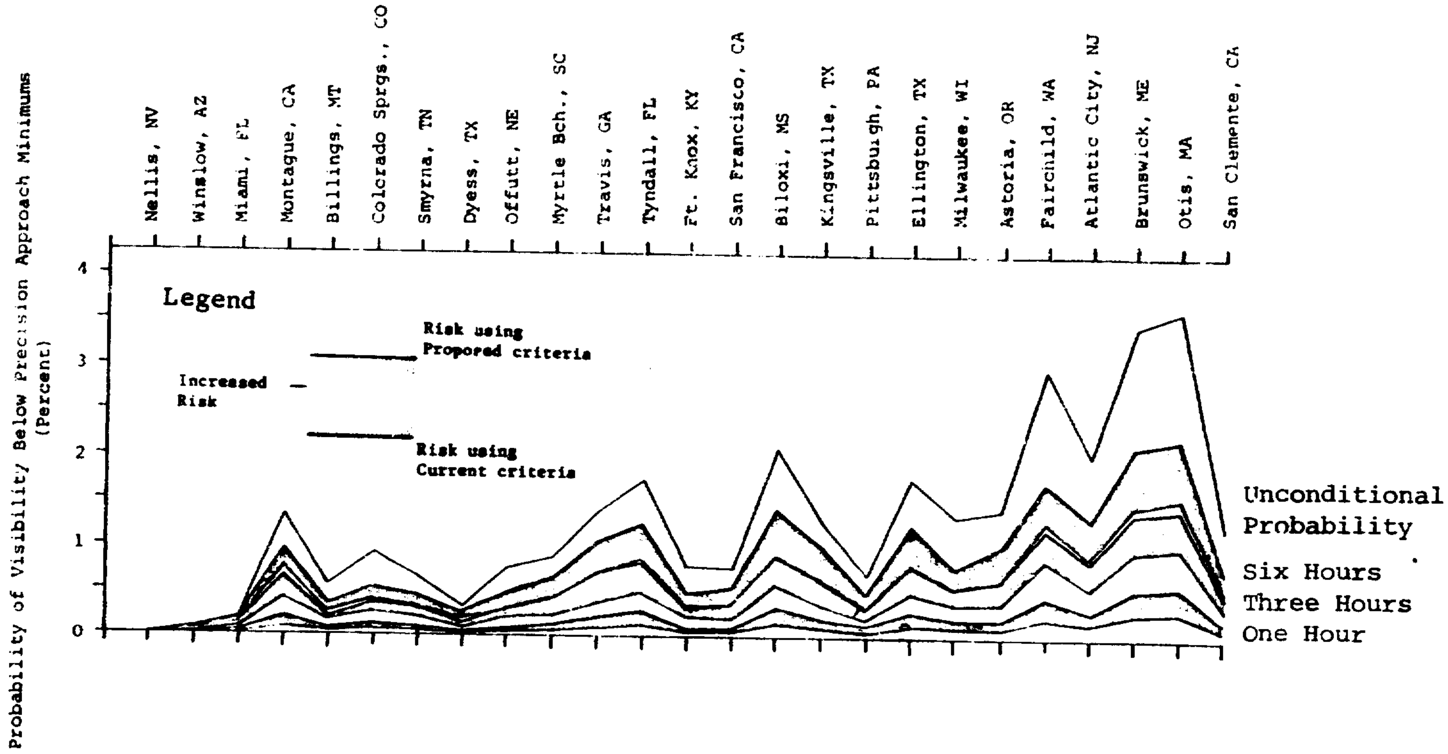

Figure 3.10 Risk for Visibilities Below Precision Approach Minimums

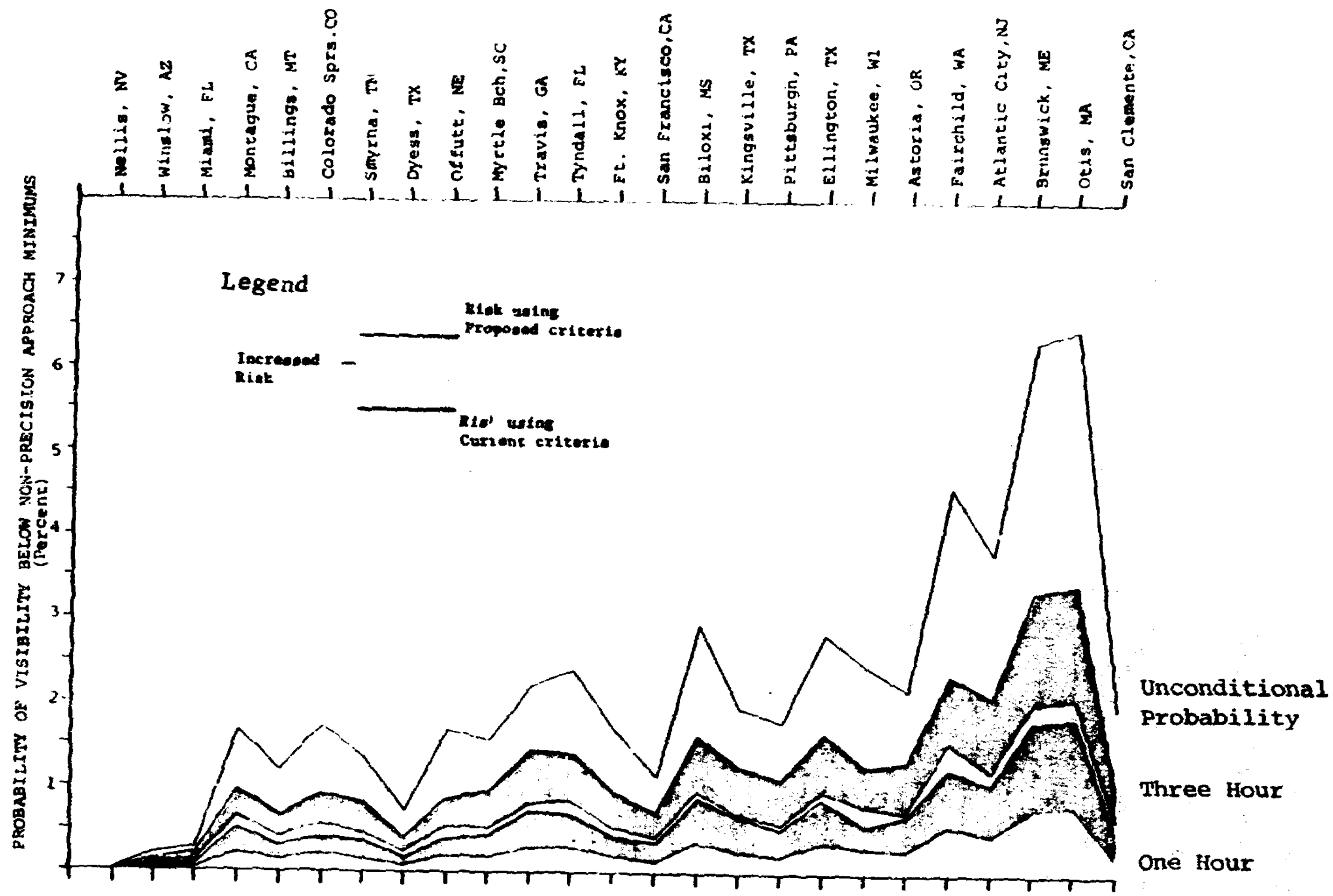

Figure 3.11 Risk For Visibility Below Non-Precision Approach Minimums (One Hour and Three Hours Later)

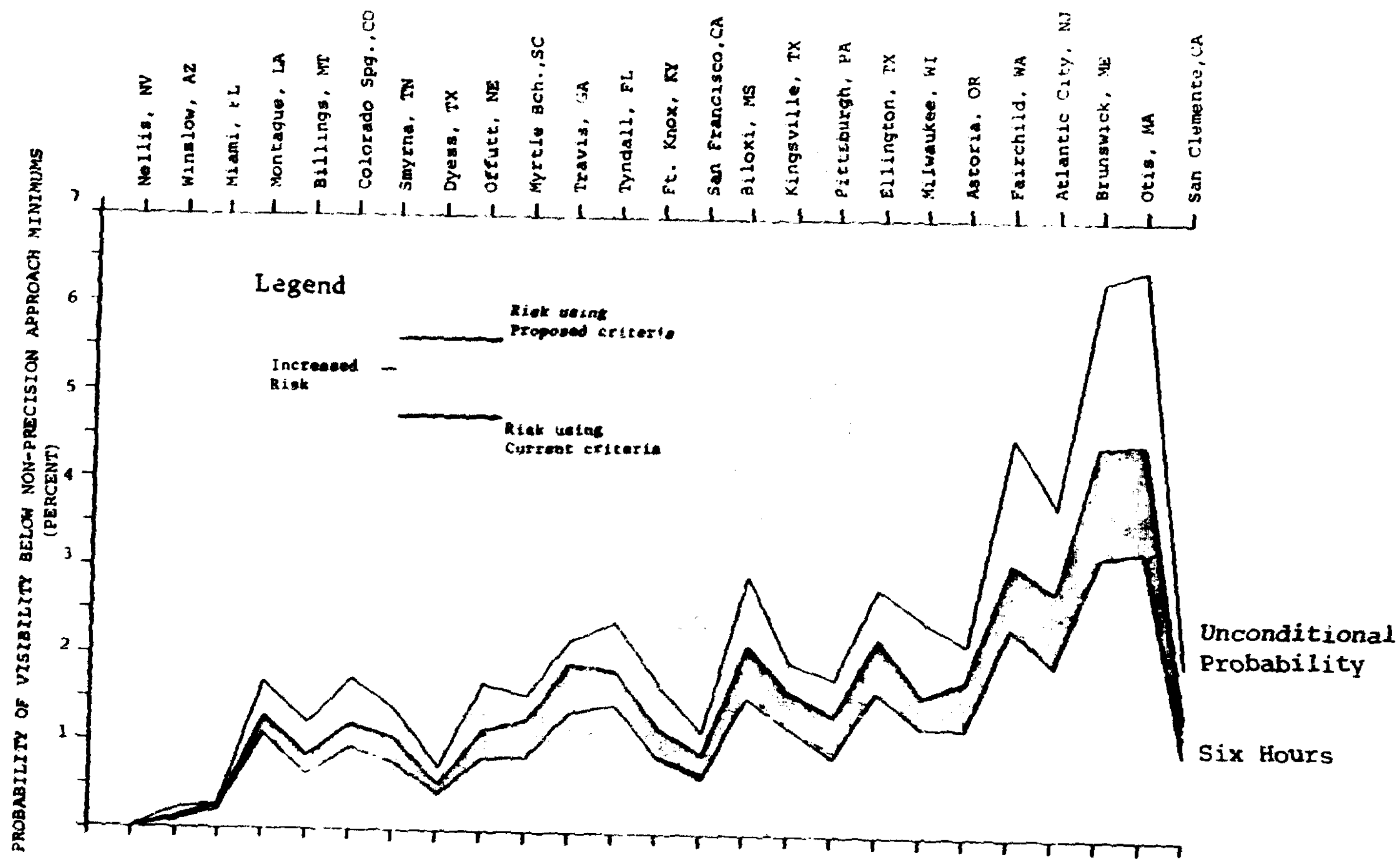

Figure 3.12 Risk For Visibility Below Non-Precision Approach Minimums (Six Hours Later)

3.3.4 Summarization of the Operational Parameters

In order to summarize the results of the twenty-five station study, the statistical mean values of the twenty-eight operational parameters were determined. These results are shown in Figures 3.13 and 3.14. As expected, these graphs show increasing risks of ceiling and visibility deterioration as the aircraft flight time increases. The shaded areas in the graphs represent additional risks in reducing alternate airport requirements from the current rules to those proposed by helicopter operators.

Three of these risk plots show that the risk at three hours under the proposed rules is about the same as the risk at six hours under the current rules. The fourth risk plot, the precision approach ceiling case shown in Figure 3.13, shows the risk at four and one-half hours under proposed rules equaling the risk at six hours under the current rules.

These summary curves indicate that the proposed alternate airport requirements tend to increase the risk of ceilings and visibilities dropping below the specified precision and non-precision approach levels during the flight. By limiting the flight time to which the reduced requirements apply, the risk can be minimized, however.

3.3.5 Candidate Alternate Airport Rule

Based on the preliminary results from this investigation of climatological data, the rule pertaining to the requirements for alternate airports in the IFR flight plan could be modified.

CURRENT REGULATION

GENERAL AVIATION

§91.83 Flight plan; information required.

(a) Information required. Unless otherwise authorized by ATC, each person filing an IFR or VFR flight plan shall include in it the following information:

•
•
•

(9) In the case of an IFR flight plan, an alternate airport, except, as provided in paragraph (b) of this section.

•
•
•

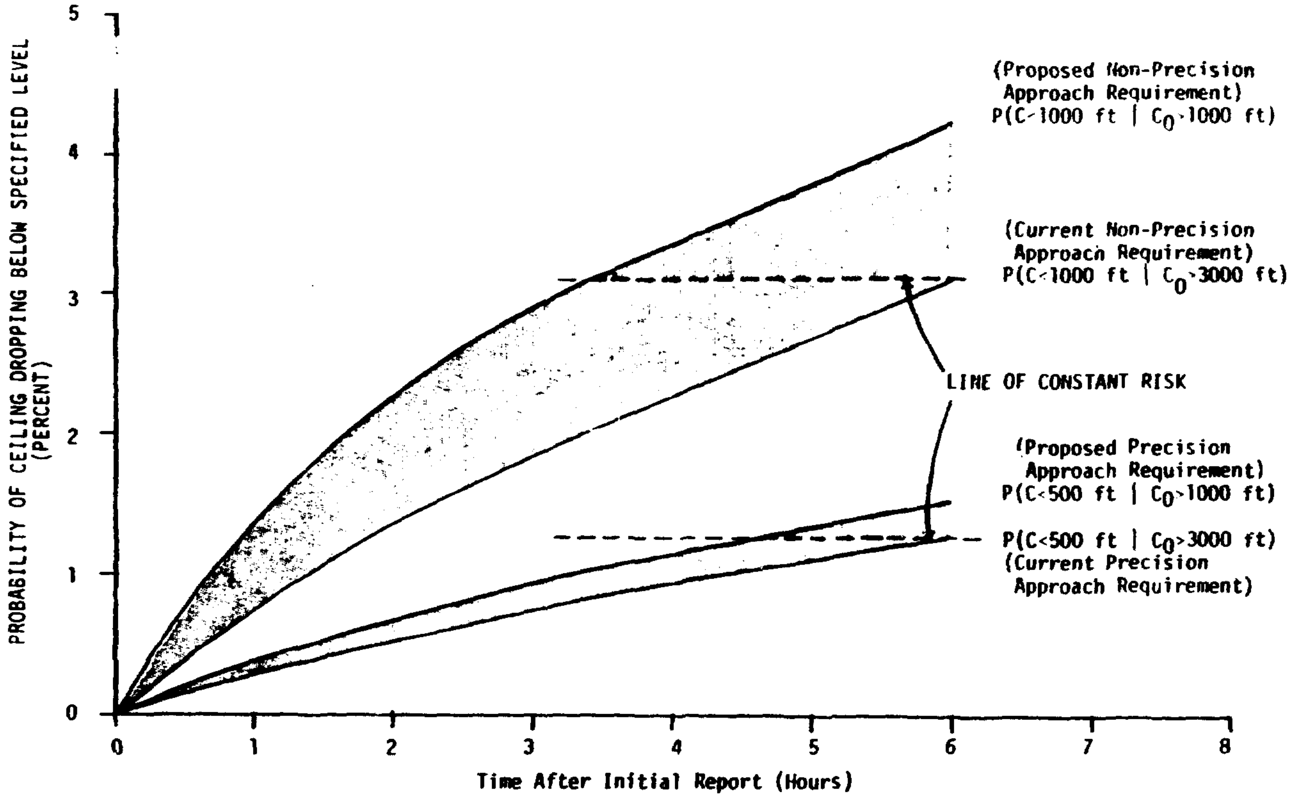

Figure 3.13 Twenty-five Station Summary for Ceilings

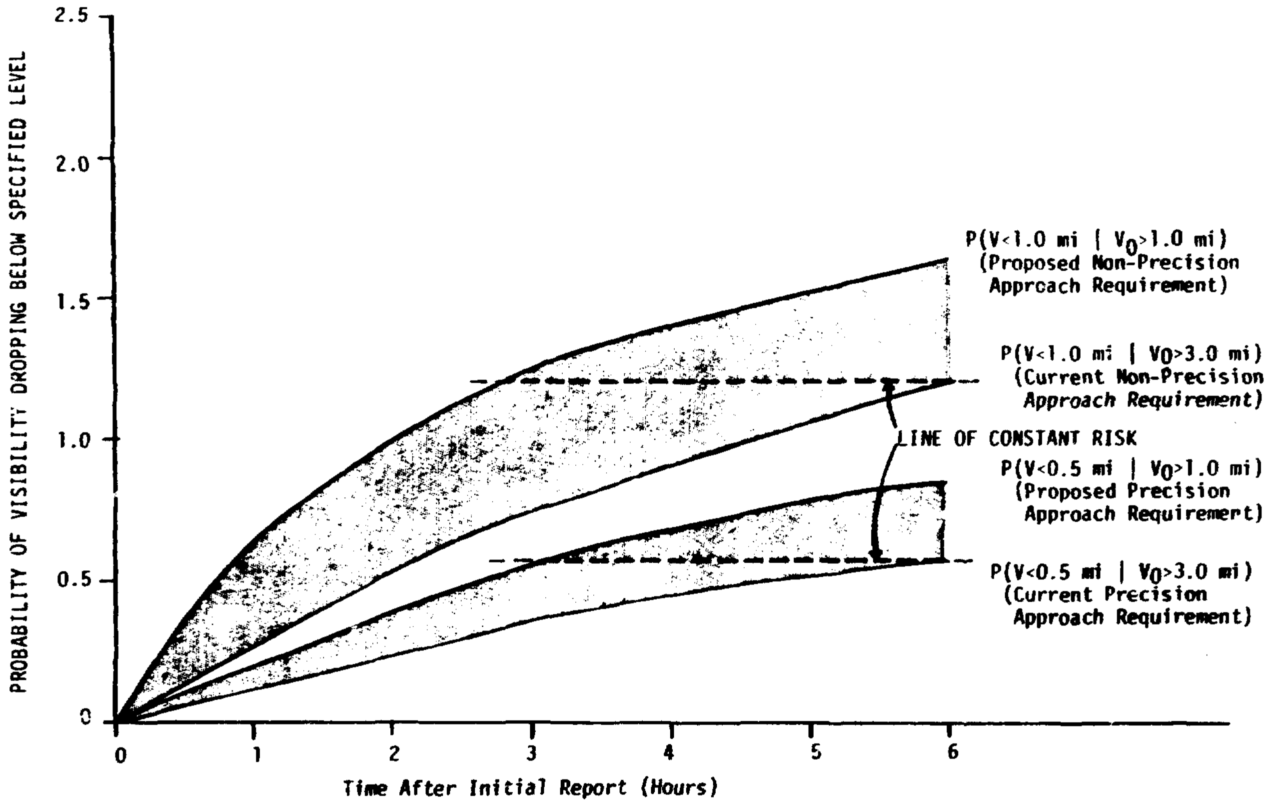

Figure 3.14 Twenty-five Station Summary for Visibilities

(b) Exceptions to applicability of paragraph (a)(9) of this section. Paragraph (a)(9) of this section does not apply if Part 97 of this subchapter prescribes a standard instrument approach procedure for the first airport of intended landing and, for at least one hour before and one hour after the estimated time of arrival, the weather reports or forecasts or any combination of them, indicate--

(1) The ceiling will be at least 2,000 feet above the airport elevation; and

(2) Visibility will be at least 3 miles.

(c) IFR alternate airport weather minimums.

Section to be Modified

•
•
•

CANDIDATE MODIFICATION

(1) For flying times of 2 hours or less (at norm l cruising speed, in still air) -

(i) The ceiling will be at least 1,000 feet above the airport elevation; and

(ii) Visibility will be at least 1 mile.

(2) For flying times greater than 2 hours -

(i) The ceiling will be at least 2,000 feet above the airport elevation; and

(ii) Visibility will be at least 3 miles.

(c) IFR alternate airport weather minimums.

•
•
•

CURRENT REGULATION

AIR TAXI OPERATIONS

§135.223 IFR: alternate airport requirements.

(a) Except as provided in paragraph (b) of this section, no person may operate an aircraft in IFR conditions unless it carries enough fuel (considering weather reports or forecasts or any combination of them) to-

(1) Complete the flight to the first airport of intended landing:

(2) Fly from that airport to the alternate airport; and

(3) Fly after that for 45 minutes at normal cruising speed.

(b) Paragraph (a)(2) of this section does not apply if Part 97 of this chapter prescribes a standard instrument approach procedure for the first airport of intended landing and, for at least one hour before and after the estimated time of arrival, the appropriate weather reports or forecasts, or any combination of them, indicate that-

(1) The ceiling will be at least 1,500 feet above the lowest circling approach MDA; or
(2) If a circling instrument approach is not authorized for the airport, the ceiling will be at least 1,500 feet above the lowest published minimum or 2,000 feet above the airport elevation, whichever is higher; and
(3) Visibility for that airport is forecast to be at least three miles, or two miles more than the lowest applicable visibility minimums, whichever is the greater, for the instrument approach procedure to be used at the destination airport.

Section to be Modified

CANDIDATE MODIFICATION

(1) For flying times of 2 hours or less (at normal cruising speed, in still air) -
(i) The ceiling will be at least 750 feet above the lowest circling approach MDA; or
(ii) If a circling instrument approach is not authorized for the airport, the ceiling will be at least 750 feet above the lowest published minimum or 1000 feet above the airport elevation, whichever is higher; and
(iii) Visibility for that airport is forecast to be at least one mile, or one-half mile more than the lowest applicable visibility minimums, whichever is the greater, for the instrument approach procedure to be used at the destination airport.
(2) For flying times of greater than 2 hours -
(i) The ceiling will be at least 1,500 feet above the lowest circling approach MDA; or
(ii) If a circling instrument approach is not authorized for the airport, the ceiling will be at least 1,500 feet above the lowest published minimum or 2,000 feet above the airport elevation, whichever is higher; and
(iii) Visibility for that airport is forecast to be at least three miles, or two miles more than the lowest applicable visibility minimums, whichever is the greater, for the instrument approach procedure to be used at the destination airport.

4.0 PRELIMINARY CONCLUSIONS

The data developed during this study effort are based on the cumulative r^2 model of conditional probabilities. Since the model has not been validated for geographical and seasonal universality the results can only be considered as tentative. Consequently, the conclusions reached at the close of the study have been identified as being preliminary.

1. The cumulative r^2 conditional probability model represents a suitable method for developing a data base for the alternate airport problem.

2. Reducing alternate airport requirements increases the risk that weather at the destination airport will be below ceiling and visibility minimums for precision and non-precision approaches.

3. Given that no alternate airport is required in the IFR flight plan the probability that the destination weather will deteriorate below precision and non-precision approach minimums increases as the duration of the flight increases.

4. Any reduction in alternate airport requirements should be offset by limiting the duration of the flights for which the reduced requirements apply. It is recommended that reduced requirements only apply to flights whose flight time is two hours or less.

REFERENCE

1. Martin, Donald E. and Myers, Eloise, "Climatic Models That Will Provide Timely Mission Success Indicators for Planning and Supporting Weather Sensitive Operators," AFGL-TR-78-0308, prepared by Saint Louis University, Department of Earth and Atmospheric Sciences, St. Louis, Missouri 63103, prepared for United States Air Force Physics Laboratory, Air Force Systems Command, Hanscom Air Force Base, Massachusetts 01731.

APPENDIX A

THE CUMULATIVE r^2 MODEL

This section contains a description of the methods employed in the development of the cumulative r^2 tables.

The following terminology is used in this development:

$P(C \leq b) = P(C = a \oplus b) = P(C = a) + P(C = b)$

where $\oplus$ implies a union of sets

Or stated in textual terms:

The probability that the ceiling C is less than or equal to Category b is equal to the probability that the ceiling is in a or Category b which is also equal to the probability that the ceiling equals Category a plus the probability that the ceiling equals Category b. This statement is true because the categories are mutually exclusive; that is, if the ceiling is in Category b it can't be in Category a or vise versa. This fact holds for all ceiling categories and all visibility categories.

As an aid to understanding the procedures for developing the cumulative r^2 values, the data from Figure A.1 is used for sample calculations. In order to develop cumulative probabilities, the following procedures were utilized:

1. The cumulative unconditional probabilities for the initial time are computed from the categorical unconditional probabilities shown at the bottom of Figure A.1.

$P(C_0 = a) = 4.4\%$	$P(C_0 = a) = 4.4\%$
$P(C_0 = b) = 14.7\%$	$P(C_0 \leq b) = 19.1\%$
$P(C_0 = c) = 11.0\%$	$P(C_0 \leq c) = 30.1\%$
$P(C_0 = d) = 10.5\%$	$P(C_0 \leq d) = 40.6\%$
$P(C_0 = e) = 20.8\%$	$P(C_0 \leq e) = 61.4\%$
$P(C_0 = f) = 38.6\%$	$P(C_0 \leq f) = 100.0\%$

2. The cumulative conditional probabilities at the subsequent time for each initial category are developed from the conditional probabilities for each category:

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 00-01 LST

CEILING CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	70	51	43	40	39	41	20	12	6	9	20	10	13
	B	16	28	39	37	32	24	33	29	24	13	15	22	15
	C	2	5	5	7	10	12	9	13	10	17	6	12	4
	D	2	6	5	4	2	5	10	11	13	6	12	15	15
	E	7	6	5	9	13	11	10	11	18	23	23	13	23
	F	2	4	4	4	4	6	20	23	28	32	24	27	30
	OBS	82	82	82	82	82	82	82	82	82	82	82	82	82
B	A	7	9	10	9	10	10	6	5	8	5	7	3	6
	B	75	64	58	54	49	48	36	25	21	30	32	21	20
	C	10	13	16	18	18	17	19	25	18	11	13	17	11
	D	3	7	8	7	8	9	12	12	11	10	7	12	12
	E	3	5	5	7	9	8	13	15	14	16	14	20	18
	F	2	3	3	5	6	8	14	18	28	28	27	27	33
	OBS	273	273	273	273	273	273	273	273	273	273	273	273	273
C	A	1	3	3	5	7	7	3	1	2	2	6	3	6
	B	18	24	24	22	24	24	21	17	15	14	18	8	16
	C	66	51	44	38	30	27	23	20	13	17	17	17	12
	D	9	12	14	19	20	19	17	21	18	11	8	18	12
	E	3	3	7	10	11	12	18	20	20	18	17	22	22
	F	2	5	7	7	8	10	18	20	32	38	35	32	31
	OBS	205	205	205	205	205	205	205	205	205	205	205	205	205
D	A	1	4	5	6	5	5	4	2	1	3	2	0	4
	B	5	8	10	12	17	17	21	14	10	16	13	15	18
	C	13	15	18	24	22	19	18	15	13	13	14	14	14
	D	66	52	41	30	27	27	18	25	24	16	17	17	9
	E	11	13	17	17	16	19	18	19	20	16	23	22	19
	F	4	7	8	11	13	12	20	25	31	35	31	32	35
	OBS	195	195	195	195	195	195	195	195	195	195	195	195	195
E	A	0	0	1	1	3	1	2	0	1	3	3	1	3
	B	4	7	7	7	8	9	9	6	5	8	12	10	12
	C	3	6	8	10	12	12	16	14	8	10	9	11	10
	D	9	11	12	12	13	13	16	19	17	13	12	15	9
	E	75	60	53	49	42	43	28	26	30	26	26	21	26
	F	9	16	19	21	22	21	30	35	39	41	37	41	41
	OBS	387	387	387	387	387	387	387	387	387	387	387	387	387
F	A	1	1	1	2	3	3	2	1	1	2	3	1	3
	B	2	3	5	7	8	10	8	6	5	8	9	8	13
	C	1	2	2	2	3	3	7	7	7	8	9	12	12
	D	1	1	2	2	2	4	7	9	10	9	9	14	9
	E	6	10	13	15	16	17	17	19	21	21	20	18	18
	F	90	83	77	72	68	64	60	58	35	52	50	47	46
	OBS	718	718	718	718	718	718	718	718	718	718	718	718	718

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	4.4	14.7	11.0	10.5	20.8	38.6
TOTAL OBS	1860	82	273	205	195	387	718

Figure A-1 Ceiling Conditional Probability Tables for Fairchild AFB, Washington

$P(C_1 = a|C_0 = a) = 70\%$ $P(C_1 = a|C_0 = a) = 70\%$

$P(C_1 = b|C_0 = a) = 16\%$ $P(C_1 \leq b|C_0 = a) = 86\%$

$P(C_1 = c|C_0 = a) = 2\%$ $P(C_1 \leq c|C_0 = a) = 88\%$

$P(C_1 = d|C_0 = a) = 2\%$ $P(C_1 \leq d|C_0 = a) = 90\%$

$P(C_1 = e|C_0 = a) = 7\%$ $P(C_1 \leq e|C_0 = a) = 97\%$

$P(C_1 = f|C_0 = a) = 2\%$ $P(C_1 \leq f|C_0 = a) = 99\%$*

*Round off error in table causes the sum to be slightly less than 100%.

$P(C_1 = a|C_0 = b) = 7\%$ $P(C_1 = a|C_0 = b) = 7\%$

$P(C_1 = b|C_0 = b) = 75\%$ $P(C_1 \leq b|C_0 = b) = 82\%$

$P(C_1 = c|C_0 = b) = 10\%$ $P(C_1 \leq c|C_0 = b) = 92\%$

$P(C_1 = d|C_0 = b) = 3\%$ $P(C_1 \leq d|C_0 = b) = 95\%$

$P(C_1 = e|C_0 = b) = 3\%$ $P(C_1 \leq e|C_0 = b) = 98\%$

$P(C_1 = f|C_0 = b) = 2\%$ $P(C_1 \leq f|C_0 = b) = 100\%$

and so forth through $P(C_1 \leq f|C_0 = f)$. The results of this step are shown in the matrix in Table A.1.

3. Compute or otherwise determine the cumulative unconditional probability values at the subsequent time. This step may be achieved utilizing tables for subsequent time periods or the values may be computed as follows:

   The unconditional probability that the ceiling is in Category a at the subsequent time is the sum of the joint probabilities that the ceiling at the subsequent time is in Category a and the ceiling at the initial time is in each of the six ceiling categories.

Table A.1 Intermediate Cumulative Probability Table (Percent)

INITIAL CATEGORY (C_0)	CUMULATIVE SUBSEQUENT CATEGORY (C_1)					
	=A	≤B	≤C	≤D	≤E	≤F*
=A	70	86	88	90	97	99
=B	7	82	92	95	98	100
=C	1	19	85	94	97	99
=D	1	6	19	85	96	100
=E	0	4	7	16	91	100
=F	1	3	4	5	11	101

*This category should equal 100%. Variations are due to roundoff error.

$$P(C_1 = a) = P(C_1 = a \oplus C_0 = a) + P(C_1 = a \oplus C_0 = b)$$
$$+P(C_1 = a \oplus C_0 = c) + P(C_1 = a \oplus C_0 = d)$$
$$+P(C_1 = a \oplus C_0 = e) + P(C \ \ = a \oplus C_0 = f)$$

The joint probabilities can be computed from the conditional probabilities by using the following relationship:

$$P(C_1 = a \oplus C_0 = a) = P(C_1 = a|C_0 = a)\ P(C_0 = a)$$
$$P(C_1 = a \oplus C_0 = b) = P(C_1 = a|C_0 = b)\ P(C_0 = b)$$

•
•
•

$$P(C_1 = a \oplus C_0 = f) = P(C_1 = a|C_0 = f)\ P(C_0 = f)$$

or $P(C_1 = a) = P(C_1 = a|C_0 = a)\ P(C_0 = a) + P(C_1 = a|C_0 = b)\ P(C_0 = b)$
$+P(C_1 = a|C_0 = c)\ P(C_0 = c) + P(C_1 = a|C_0 = d)\ P(C_0 = d)$
$+P(C_1 = a|C_0 = e)\ P(C_0 = e) + P(C \ \ = a|C_0 = f)\ P(C_0 = f)$

and similarily,

$$P(C_1 \le b) = P(C_1 \le b \oplus C_0 = a) + P(C_1 \le b \oplus C_0 = b)$$
$$+P(C_1 \le b \oplus C_0 = c) + P(C_1 \le b \oplus C_0 = d)$$
$$+P(C_1 \le b \oplus C_0 = e) + P(C_1 \le b \oplus C_0 = f)$$

or $P(C_1 \le b) = P(C_1 \le b|C_0 = a)\ P(C_0 = a) + P(C_1 \le b|C_0 = b)\ P(C_0 = b)$
$+P(C_1 \le b|C_0 = c)\ P(C_0 = c) + P(C_1 \le b|C_0 = d)\ P(C_0 = d)$
$+P(C_1 \le b|C_0 = e)\ P(C_0 = e) + P(C_1 \le b|C_0 = f)\ P(C_0 = f)$

Similarily, the unconditional probabilities $P(C_1 \le c)$, $P(C_1 \le d)$, etc. can be computed from the conditional probabilities and unconditional probabilities for the initial ceilings, C_0.

From Table A.1 and the data from Step 1 example computations for $P(C_1 = a)$ and $P(C_1 \le b)$ are as follows:

$$P(C_1 = a) = .70 * .044 + .07 * .147 + .01 * .10 + .01 * .105 + .00 * .208 + .01 * .386 = .0471 = 4.7\%$$

$$P(C_1 \le b) = .86 * .044 + .82 * .147 + .19 * .110 + .06 * .105 + .04 * .208 + .03 * .386 = .2054 = 20.5\%$$

The unconditional probabilities for C_1 are as follows:

$P(C_1 = a) = 4.7\%$

$P(C_1 \leq b) = 20.5\%$

$P(C_1 \leq c) = 31.7\%$

$P(C_1 \leq d) = 42.4\%$

$P(C_1 \leq e) = 62.6\%$

$P(C_1 \leq f) = 100.2\%$ (100.0 %)

4. It is now necessary to determine the cumulative conditional probabilities.

$$
\begin{array}{lllll}
P(C = a|C_0 = a) & P(C \leq b|C_0 = a) & \bullet \quad \bullet \quad \bullet & P(C \leq f|C_0 = a) \\
P(C = a|C_0 \leq b) & P(C \leq b|C_0 \leq b) & \bullet \quad \bullet \quad \bullet & P(C \leq f|C_0 \leq b) \\
P(C = a|C_0 \leq c) & P(C \leq b|C_0 \leq c) & \bullet \quad \bullet \quad \bullet & P(C \leq f|C_0 \leq c) \\
\vdots & \vdots & & \vdots \\
P(C = a|C_0 \leq f) & P(C \leq b|C_0 \leq f) & \bullet \quad \bullet \quad \bullet & P(C \leq f|C_0 \leq f)
\end{array}
$$

These values are computed from Table A.1 as follows:

The first row remains intact as these values are the required conditional probabilities.

The second row requires these computations:

$$
\begin{aligned}
P(C_1 = a|C_0 \leq b) &= \frac{P(C_1 = a \oplus C_0 < b)}{P(C_0 \leq b)} \\
&= \frac{P(C_1 = a \oplus C_0 = a) + P(C_1\ a \oplus C_0 = b)}{P(C_0 \leq b)} \\
&= \frac{P(C_1 = a|C_0 = a)\ P(C_0 = a) + P(C_1 = a|C_0 = b)\ P(C_0 = b)}{P(C_0 = a) + P(C_0 = b)}
\end{aligned}
$$

Similarily

$$
P(C_1 < b|C_0 < b) = \frac{P(C_1 < b|C_0 = a)\ P(C_0 = a) + P(C_1 \leq b|C_0 = b)\ P(C_0 = b)}{P(C_0 = a) + P(C_0 = b)}
$$

$$
P(C_1 \leq b|C_0 \leq C) = \frac{P(C_1 \leq b|C_0 = a) P(C_0 = a) + P(C_1 \leq b|C_0 = b)\ P(C_0 = b) + P(C_1 \leq b|C_0 = c)\ P(C_0 = c)}{P(C_0 = a) + P(C_0 = b) + P(C_0 = c)}
$$

etc.

These conditional probabilities are shown in Table A.2.

Table A.2 Cumulative Conditional Probability Table

CUMULATIVE INITIAL CATEGORY(C_0)	CUMULATIVE SUBSEQUENT CATEGORY (C_1) (Percent)					
	= A	<B	<C	<D	<E	<F*
= A	70.0	86.0	88.0	90.0	97.0	99.0
$\leq$ B	21.5	82.9	91.1	93.8	97.8	99.8
$\leq$ C	14.0	59.6	88.9	93.9	97.5	99.5
$\leq$ D	10.7	45.7	70.8	91.6	97.6	99.6
$\leq$ E	7.0	31.6	49.2	66.0	95.0	99.7
$\leq$ F**	4.7	20.5	31.7	42.4	62.6	100.2

*with no round off error this column would equal 100% for all entries.

**This row is the unconditional probability values for C_1 since C_0 is less than or equal to Category F with unity probability.

5. It is now possible to use equations (16) and (17) from Reference 1, to solve for an r^2 table using the data shown in Figure A.1.

$$r^2 = \frac{P(C_1 \leq X|C_0 \leq Y) - P(C_1 \leq X)}{1 - P(C_1 \leq X)} \text{ for } P(C_0 \leq Y) \leq P(C_1 \leq X) \qquad (A.1)$$

$$r^2 = \frac{P(C_1 \leq X|C_0 \leq Y) - P(C_1 \leq X)}{P(C_1 \leq X)\ (1/\ (P(C_0 \leq Y)\ -1)} \text{ for } (P(C_0 \leq 4) > P(C_1 \leq Y) \qquad (A.2)$$

These computations are as follows:

for C = a, C_0 = a

$P(C_1 = a|C_0 = a) = .70$; $P(C_1 = a) = .047$; $P(C_0 = a) = .044$

Therefore using Equation A.1: $r^2 = \frac{.70 - .047}{1 - .047} = .685$

for $C_1 \leq b$, $C_0 = a$

$P(C_1 \leq b|C_0 = a) = .86$; $P(C_1 \leq b) = .205$; $P(C_0 = a) = .044$

therefore using Equation A.1: $r^2 = \frac{.86 - .205}{1 - .205} = .824$

for $C_1 = a$, $C_0 \leq b$

$P(C_1 = a|C_0 \leq b) = .215$; $P(C_1 \leq a) = .047$; $P(C_0 \leq b) = .191$

Therefore using Equation A.2: $r^2 = \dfrac{.215 - .047}{.047(1/.191-1)} = .842$

The table of r^2 values for the data shown in Figure A.1 is presented in Table A.3.

Table A.3 Table of r^2 Values for Fairchild AFB, Washington January - (00-01 LST) (Value Times 100)

INITIAL CATEGORY C_0	SUBSEQUENT CATEGORY (C_1)				
	=A	<=B	<=C	<=D	<=E
=A	68.5	82.4	82.4	82.6	92.0
<=B	84.2	78.5	86.9	89.3	94.0
<=C	85.1	81.8	83.7	89.4	93.3
<=D	86.2	83.7	84.1	85.4	92.3
<=E	78.8	85.4	87.4	83.2	86.7

APPENDIX B

PERSISTENCY PROBABILITY TABLES FOR FAIRCHILD AIR FORCE BASE, WASHINGTON FOR JANUARY

The following pages contain the persistency probability tables (conditional probabilities) for Fairchild Air Force Base, Washington. The data in percentages are of the form:

$P(C_N = X|C_0 = Y)$

The probability, that the ceiling is in Category X in N hours (C_N) given that the initial ceiling (C_0) is in Category Y; and

$P(V_N = U|V_0 = W)$

The probability that the visibility is in Category U in N hours (V_N) given that the initial visibility is in Category W.

The initial Categories, A-F for ceilings and J-O for visibilities, are in the far left column labeled INIT. The subsequent categories N hours later are located in the second column labeled SUBS. The hours, N, are found in the first row and head each of thirteen columns.

Unconditional probabilities for each category are found in the table at the bottom of the page. The rows labeled OBS refer to the number of observations that are used to determine the probability values.

The ceiling categories are:

A = less than 200 feet

B = 200 feet - 499 feet

C = 500 feet - 999 feet

D = 1000 feet 2999 feet

E = 3000 feet - 9999 feet

F = 10,000 feet and greater

The visibility categories are:

J = less than 0.5 mile

K = 0.5 mile but less than 1.0 mile

L = 1.0 mile but less than 2.0 miles

M = 2.0 miles but less than 3.0 miles

N = 3.0 miles but less than 6.0 miles

O = 6.0 miles and greater

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 00-01 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	70	51	43	40	39	41	20	12	6	9	20	10	13
	B	16	28	39	37	32	24	33	29	24	13	15	23	15
	C	2	5	5	7	10	12	9	13	10	17	6	12	4
	D	2	6	5	4	2	5	10	11	13	6	12	15	15
	E	7	6	5	9	13	11	10	11	18	23	23	13	23
	F	2	4	4	4	4	6	20	23	28	32	24	27	30
	OBS	82	82	82	82	82	82	82	82	82	82	82	82	82
B	A	7	9	10	9	10	10	6	5	8	5	7	3	6
	B	75	64	58	54	49	48	36	25	21	30	32	21	20
	C	10	13	16	18	18	17	19	25	18	11	13	17	11
	D	3	7	8	7	8	9	12	12	11	10	7	12	12
	E	3	5	5	7	9	8	13	15	14	16	14	20	18
	F	2	3	3	5	6	8	14	18	28	28	27	27	33
	OBS	273	273	273	273	273	273	273	273	273	273	273	273	273
C	A	1	3	3	5	7	7	3	1	2	2	6	3	6
	B	18	24	24	22	24	24	21	17	15	14	18	8	16
	C	66	51	44	38	30	27	23	20	13	17	17	17	12
	D	9	12	14	19	20	19	17	21	18	11	8	18	12
	E	3	3	7	10	11	12	18	20	20	18	17	22	22
	F	2	5	7	7	8	10	18	20	32	38	35	32	31
	OBS	205	205	205	205	205	205	205	205	205	205	205	205	205
D	A	1	4	5	6	5	5	4	2	1	3	2	0	4
	B	5	8	10	12	17	17	21	14	10	16	13	15	18
	C	13	15	18	24	22	19	18	15	13	13	14	14	14
	D	66	52	41	30	27	27	18	25	24	16	17	17	9
	E	11	13	17	17	16	19	18	19	20	16	23	22	19
	F	4	7	8	11	13	12	20	25	31	35	31	32	35
	OBS	195	195	195	195	195	195	195	195	195	195	195	195	195
E	A	0	0	1	1	3	1	2	0	1	3	3	1	3
	B	4	7	7	7	8	9	9	6	5	8	12	10	12
	C	3	6	8	10	12	12	16	14	8	10	9	11	10
	D	9	11	12	12	13	13	16	19	17	13	12	15	9
	E	75	60	53	49	42	43	28	26	30	26	25	21	26
	F	9	16	19	21	22	21	30	35	39	41	37	41	41
	OBS	387	387	387	387	387	387	387	387	387	387	387	387	387
F	A	1	1	1	2	3	3	2	1	1	2	3	1	3
	B	2	3	5	7	8	10	8	6	5	8	9	8	13
	C	1	2	2	2	3	3	7	7	7	8	9	12	12
	D	1	1	2	2	2	4	7	9	10	9	9	14	9
	E	6	10	13	15	16	17	17	19	21	21	20	18	18
	F	90	83	77	72	68	64	60	58	55	52	50	47	46
	OBS	718	718	718	718	718	718	718	718	718	718	718	718	718

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	4.4	14.7	11.0	10.5	20.8	38.6
TOTAL OBS	1860	82	273	205	195	387	718

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 00-01 LST
WIND SECTOR ALL

VISIBILITY CATEGORY / HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	78	62	55	47	47	48	37	22	16	22	28	14	18
	K	12	17	16	17	16	12	12	5	9	6	8	10	6
	L	4	6	7	8	8	9	13	14	8	8	11	13	9
	M	2	4	2	3	3	2	3	3	6	4	3	3	3
	N	1	3	7	5	5	6	8	20	18	16	3	16	8
	O	2	8	14	19	22	22	27	35	43	44	47	43	57
	OBS	172	172	172	172	172	172	172	172	172	172	172	172	172
K	J	23	25	20	23	20	22	19	12	12	13	19	13	19
	K	47	42	38	27	29	26	14	9	8	8	13	2	12
	L	15	13	16	18	19	20	16	16	12	11	5	13	4
	M	3	2	4	8	10	3	7	11	9	3	3	9	5
	N	5	8	7	8	9	9	19	18	19	18	9	11	9
	O	5	10	14	16	14	19	25	34	41	47	51	52	51
	OBS	91	91	91	91	91	91	91	91	91	91	91	91	91
L	J	7	8	8	13	19	16	20	10	9	10	18	7	16
	K	16	19	23	17	13	14	14	13	7	8	12	5	7
	L	53	42	33	25	22	22	14	13	14	19	9	12	13
	M	13	7	5	10	6	5	4	4	2	4	3	4	2
	N	6	12	13	11	12	13	20	18	18	4	6	12	7
	O	5	13	17	24	29	29	28	42	50	55	53	60	55
	OBS	112	112	112	112	112	112	112	112	112	112	112	112	112
M	J	3	3	5	3	5	7	12	7	7	3	7	3	10
	K	5	8	5	10	20	20	20	8	3	2	7	7	10
	L	17	22	18	17	13	15	8	17	8	18	5	8	5
	M	45	30	18	8	5	8	5	10	8	8	8	7	3
	N	13	18	25	28	20	20	27	27	22	8	15	13	2
	O	17	18	28	33	37	30	28	32	52	60	58	62	70
	OBS	60	60	60	60	60	60	60	60	60	60	60	60	60
N	J	0	2	7	10	10	10	7	4	5	7	10	4	13
	K	5	9	7	7	8	12	13	5	5	6	6	1	3
	L	13	15	13	13	12	11	18	10	6	10	9	13	10
	M	8	8	4	4	6	5	11	4	4	2	5	2	4
	N	44	36	32	20	17	12	11	21	16	11	10	19	7
	O	30	30	38	46	48	51	40	56	63	65	60	60	63
	OBS	136	136	136	136	136	136	136	136	136	136	136	136	136
O	J	1	2	3	4	4	4	4	2	2	3	5	3	6
	K	0	2	3	2	3	4	5	3	3	2	3	4	4
	L	1	2	2	3	4	4	6	5	5	5	5	6	5
	M	1	1	1	1	1	2	3	3	2	3	3	3	3
	N	4	5	5	6	6	7	11	9	9	9	7	12	7
	O	93	88	85	83	81	78	71	77	80	79	76	71	74
	OBS	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289	1289

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	9.2	4.9	6.0	3.2	7.3	69.3
TOTAL OBS	1860	172	91	112	60	136	1289

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
FOR 6/49-5/79
HOUR 02-03 LST

CEILING CATEGORY INIT	SUBS	HOURS SUBSEQUENT 1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	76	65	63	53	44	34	15	9	9	11	15	7	16
	B	16	25	25	28	29	30	29	31	19	24	25	21	22
	C	3	4	6	9	12	15	18	19	17	9	18	13	6
	D	3	1	1	2	3	6	6	8	8	7	8	16	13
	E	0	1	2	1	2	3	10	13	13	17	13	17	17
	F	1	3	3	6	8	12	22	19	34	33	21	22	26
	OBS	89	89	89	89	89	89	89	89	89	89	89	89	89
B	A	5	7	7	8	9	7	6	6	5	5	10	4	6
	B	79	65	58	56	52	47	28	22	26	28	27	15	22
	C	10	16	18	18	16	16	22	18	14	12	10	15	12
	D	4	7	9	7	7	12	16	18	9	8	10	14	11
	E	2	3	5	6	8	8	13	13	19	16	16	21	19
	F	1	2	3	5	8	10	14	22	27	31	27	31	30
	OBS	313	313	313	313	313	313	313	313	313	313	313	313	313
C	A	0	2	4	6	5	4	1	3	5	3	7	5	6
	B	17	22	25	26	28	31	20	12	11	18	19	11	19
	C	66	51	39	31	26	23	25	18	17	15	14	11	13
	D	8	12	15	18	19	16	19	19	17	15	11	14	11
	E	5	8	10	11	11	12	18	22	23	17	19	22	21
	F	4	4	7	8	11	13	17	26	27	33	30	38	31
	OBS	209	209	209	209	209	209	209	209	209	209	209	209	209
D	A	0	2	4	2	1	2	0	0	2	2	1	2	4
	B	4	6	9	12	12	13	10	9	13	17	18	10	18
	C	16	25	26	23	24	26	23	19	18	14	14	13	13
	D	64	45	36	35	30	24	27	21	14	9	17	16	13
	E	11	16	19	19	20	17	17	25	22	23	18	22	18
	F	4	5	5	8	12	18	23	26	31	34	32	37	33
	OBS	202	202	202	202	202	202	202	202	202	202	202	202	202
E	A	1	1	2	1	0	1	1	1	1	3	3	2	4
	B	2	3	5	5	6	6	5	4	5	9	14	9	17
	C	3	3	7	9	12	13	11	8	11	6	11	9	12
	D	8	10	13	13	12	13	15	17	14	12	11	18	9
	E	76	67	55	53	49	41	31	33	29	28	25	21	19
	F	11	15	19	19	22	25	36	37	40	42	36	41	39
	OBS	352	352	352	352	352	352	352	352	352	352	352	352	352
F	A	0	1	1	2	2	2	1	1	2	2	3	1	2
	B	2	3	5	7	8	8	6	5	6	8	13	7	11
	C	1	1	2	2	3	4	5	6	8	8	9	9	10
	D	0	1	1	2	4	5	6	9	8	9	11	12	11
	E	9	12	14	16	16	17	17	20	18	20	17	22	18
	F	88	82	77	71	66	65	64	59	53	53	47	48	45
	OBS	695	695	695	695	695	695	695	695	695	695	695	695	695

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	4.8	16.8	11.2	10.9	18.9	37.4
TOTAL OBS	1860	89	313	209	202	352	695

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 02-03 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	74	67	62	60	59	51	29	20	23	17	25	8	15
	K	15	15	15	14	10	12	8	8	8	7	13	10	5
	L	5	7	7	11	11	11	13	9	8	14	8	11	11
	M	1	2	4	2	3	4	5	6	5	4	4	4	4
	N	2	2	4	2	7	10	17	17	14	12	5	14	5
	O	2	7	8	11	10	11	28	40	42	46	46	53	60
	OBS	167	167	167	167	167	167	167	167	167	167	167	167	167
K	J	16	21	19	17	15	17	6	6	6	10	22	9	12
	K	55	34	38	30	27	22	14	9	8	11	8	6	16
	L	13	17	14	16	16	13	8	10	13	13	10	6	9
	M	2	6	4	4	6	8	10	2	4	2	3	4	6
	N	8	11	8	14	6	12	21	21	14	7	7	20	7
	O	6	12	17	20	29	28	42	53	55	56	50	55	50
	OBS	125	125	125	125	125	125	125	125	125	125	125	125	125
L	J	6	10	11	11	16	17	10	8	10	11	13	6	16
	K	16	12	9	11	17	21	13	8	9	11	7	7	11
	L	48	35	28	28	26	24	13	10	6	12	9	10	8
	M	6	7	9	10	6	5	7	2	6	3	9	6	6
	N	12	17	13	14	14	15	27	27	10	10	14	15	10
	O	12	20	25	26	20	18	29	44	59	52	48	56	50
	OBS	126	126	126	126	126	126	126	126	126	126	126	126	126
M	J	2	5	10	16	11	11	10	10	3	11	10	10	13
	K	5	10	11	16	16	24	5	5	5	5	10	5	6
	L	25	21	24	17	22	13	16	6	13	6	11	11	10
	M	29	14	3	6	6	6	16	5	5	8	2	2	3
	N	22	21	16	14	13	14	17	19	14	16	13	19	8
	O	17	30	37	30	32	32	37	56	60	54	56	54	60
	OBS	63	63	63	63	63	63	[illegible]	63	63	63	63	63	63
N	J	3	5	7	7	10	7	3	3	7	5	10	2	10
	K	5	8	7	8	7	12	7	8	6	8	10	5	8
	L	9	9	7	10	14	10	12	9	9	11	8	8	5
	M	8	5	6	4	4	6	6	7	3	2	3	3	5
	N	46	30	30	24	17	20	24	15	11	7	11	12	16
	O	29	42	44	48	48	44	48	58	64	67	58	70	56
	OBS	153	153	153	153	153	153	153	153	153	153	153	153	153
O	J	1	2	3	3	3	4	2	1	2	4	5	3	7
	K	1	2	2	3	4	4	3	3	2	4	5	4	5
	L	0	2	3	3	4	6	5	5	6	4	6	5	6
	M	0	1	1	2	2	3	3	2	2	3	3	2	3
	N	4	4	4	6	8	9	9	8	8	7	8	10	8
	O	93	90	87	83	78	75	77	81	79	79	73	76	71
	OBS	1226	1226	1226	1226	1226	1226	1226	1226	1226	1226	1226	1226	1226

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	9.0	6.7	6.8	3.4	8.2	65.9
TOTAL OBS	1860	167	125	126	63	153	1226

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 04-05 LST

CEILING CATEGORY		HOURS SUBSEQUENT												
INIT	OBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	77	58	47	37	30	24	12	7	11	22	17	9	12
	B	20	25	22	25	27	24	29	25	26	16	23	19	22
	C	0	6	12	13	10	17	18	19	9	8	17	17	15
	D	1	5	5	5	6	6	7	8	10	17	6	13	7
	E	0	1	3	5	7	9	13	15	10	8	13	16	19
	F	2	5	11	15	20	20	21	26	34	29	24	26	25
	OBS	100	100	100	100	100	100	100	100	100	100	100	100	100
B	A	7	9	9	7	5	4	4	6	4	5	8	4	7
	B	76	66	60	53	46	37	27	21	31	32	27	14	27
	C	10	13	15	17	19	25	23	17	12	12	13	16	11
	D	3	4	5	8	12	12	14	12	7	9	10	12	9
	E	3	4	5	7	9	10	13	17	17	14	19	19	20
	F	2	4	6	8	10	12	19	28	29	28	23	34	27
	OBS	319	319	319	319	319	319	319	319	319	319	319	319	319
C	A	1	3	3	3	3	3	3	3	3	4	11	3	6
	B	14	22	27	27	21	20	11	13	16	18	22	13	18
	C	71	51	39	36	36	31	22	13	13	15	15	13	14
	D	9	15	16	16	16	17	26	19	11	13	6	11	12
	E	3	6	8	9	11	16	20	26	22	19	22	22	18
	F	2	3	6	9	13	14	18	26	34	31	24	39	33
	OBS	232	232	232	232	232	232	232	231	232	232	232	232	232
D	A	2	2	1	1	1	1	1	2	2	3	2	5	5
	B	3	3	11	11	9	7	10	9	16	14	16	11	22
	C	11	13	17	21	23	23	16	12	16	16	17	8	12
	D	67	52	42	34	28	25	22	22	11	14	12	16	11
	E	13	17	17	16	19	19	22	21	17	16	23	19	19
	F	3	8	12	17	19	24	28	34	39	38	30	41	31
	OBS	180	180	180	180	180	180	180	180	180	180	180	179	180
E	A	1	1	1	1	1	0	1	1	3	3	2	1	5
	B	3	5	6	8	8	8	4	5	9	10	19	8	16
	C	3	6	9	10	12	11	12	12	9	8	11	7	11
	D	8	11	11	12	13	13	17	12	12	10	8	12	9
	E	76	65	56	46	39	37	35	32	30	31	23	28	24
	F	9	12	17	22	27	30	31	37	37	37	38	45	35
	OBS	379	379	379	379	379	379	379	379	379	379	379	379	379
F	A	0	1	2	1	1	1	0	1	1	1	3	1	4
	B	2	3	4	[illegible]	5	3	5	5	8	8	10	7	13
	C	0	1	2	2	2	2	4	5	6	7	11	9	13
	D	1	2	2	4	6	7	8	9	10	10	12	12	9
	E	6	12	15	13	15	15	17	16	18	20	18	19	20
	F	90	81	75	72	71	72	65	64	57	54	46	52	42
	OBS	650	650	650	650	650	650	650	650	650	650	650	650	650

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	5.4	17.2	12.5	9.7	20.4	34.9
TOTAL OBS	1860	100	319	232	180	379	650

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 04-05 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	77	67	61	51	41	34	21	21	21	24	20	15	17
	K	13	16	15	14	13	6	7	6	7	12	16	5	7
	L	2	4	8	14	13	13	9	13	11	6	9	10	6
	M	2	2	4	6	6	7	4	4	3	2	3	4	3
	N	3	4	3	6	12	19	14	11	9	9	10	14	10
	O	3	7	8	9	15	20	44	45	48	47	43	52	57
	OBS	180	180	180	180	180	180	180	180	180	180	180	180	180
K	J	18	23	23	23	21	13	8	4	13	13	19	4	12
	K	53	39	23	23	18	19	11	8	6	6	13	10	10
	L	15	11	14	10	13	11	12	11	12	10	8	8	11
	M	3	3	5	4	4	7	2	6	5	3	3	7	3
	N	6	13	13	14	19	18	23	23	14	10	10	16	6
	O	6	11	22	26	25	33	44	49	51	58	48	55	58
	OBS	120	120	120	120	120	120	120	120	120	120	120	120	120
L	J	5	8	11	16	10	13	9	6	13	10	15	7	13
	K	13	13	24	23	23	14	6	9	6	8	9	9	7
	L	52	44	31	23	25	20	14	5	10	13	8	9	12
	M	9	7	8	6	6	9	5	6	4	2	2	2	1
	N	11	13	14	16	17	18	22	19	12	9	11	11	10
	O	9	16	12	15	18	26	44	55	55	59	55	62	58
	OBS	128	128	128	128	128	128	128	127	128	128	128	128	128
M	J	12	12	10	12	14	6	6	8	6	10	10	8	12
	K	6	16	20	20	20	16	14	4	14	6	12	2	10
	L	18	20	32	20	12	12	8	10	10	24	10	12	14
	M	26	14	2	4	8	12	6	6	4	0	2	4	4
	N	20	16	16	22	22	26	14	16	16	6	6	10	18
	O	18	22	20	22	24	28	52	56	50	54	60	64	42
	OBS	50	50	50	50	50	50	50	50	50	50	50	50	50
N	J	4	4	6	8	7	5	7	9	12	14	14	5	13
	K	5	9	14	12	10	9	6	5	3	9	3	7	7
	L	14	14	16	14	14	15	12	10	15	6	8	9	9
	M	6	4	7	8	7	6	5	5	1	5	3	3	2
	N	40	32	20	26	24	23	18	13	9	13	11	10	7
	O	31	38	37	32	37	42	52	57	59	53	61	66	63
	OBS	148	148	148	148	148	148	148	148	148	148	148	148	148
O	J	1	2	3	3	3	2	1	2	2	3	6	2	8
	K	1	2	2	4	3	4	3	3	3	3	5	3	6
	L	1	3	4	5	5	5	5	6	5	5	6	6	5
	M	1	2	2	3	3	3	2	3	2	3	3	3	3
	N	4	5	7	8	10	8	9	8	8	7	7	9	8
	O	92	87	82	78	76	77	80	80	80	79	73	76	70
	OBS	1234	1234	1234	1234	1234	1234	1234	1234	1234	1234	1234	1234	1234

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	9.7	6.5	6.9	2.7	8.0	66.3
TOTAL OBS	1860	180	120	128	50	148	1234

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 06-07 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	69	50	37	26	21	15	7	13	15	21	21	12	15
	B	16	26	27	36	29	29	26	29	28	18	20	23	18
	C	6	7	10	7	17	17	15	10	4	9	16	12	15
	D	3	6	6	6	9	11	14	8	11	17	10	13	7
	E	2	1	5	8	11	11	17	13	16	10	15	10	20
	F	5	11	17	17	13	17	21	27	27	25	18	30	25
	OBS	109	109	109	109	109	109	109	109	109	109	109	109	109
B	A	6	5	4	6	4	5	7	4	6	5	8	4	7
	B	75	60	51	39	34	30	18	26	28	30	29	19	26
	C	11	20	22	25	29	28	22	16	14	15	16	16	12
	D	3	5	9	11	12	13	15	13	11	8	13	8	12
	E	2	4	6	10	9	11	17	14	13	15	12	20	17
	F	3	6	7	10	11	13	22	28	27	27	22	33	26
	OBS	341	341	341	341	341	341	341	341	341	341	341	341	341
C	A	1	1	2	2	1	1	2	3	2	5	6	2	6
	B	18	23	20	15	15	14	16	17	15	18	20	18	23
	C	59	44	42	41	33	26	16	18	16	13	12	12	10
	D	12	15	14	13	18	23	22	9	11	13	14	15	13
	E	4	6	9	13	15	15	18	21	21	22	16	18	19
	F	6	10	14	17	18	20	27	32	34	29	32	36	28
	OBS	222	222	222	222	222	222	222	222	222	222	222	222	222
D	A	0	0	0	1	0	0	2	3	5	5	7	4	6
	B	6	10	10	6	7	9	8	12	19	15	17	13	22
	C	16	18	20	22	18	16	10	13	12	15	15	8	9
	D	58	43	37	36	34	33	26	17	13	10	9	13	11
	E	14	20	20	18	21	23	22	20	18	22	24	18	18
	F	6	8	13	17	20	20	33	34	33	32	28	45	34
	OBS	196	196	196	196	196	196	196	196	196	196	196	196	196
E	A	0	0	1	1	1	1	1	2	3	3	3	2	4
	B	2	4	4	7	7	5	5	9	9	9	19	9	19
	C	4	6	6	7	7	9	7	10	9	10	8	8	10
	D	9	13	15	14	16	17	14	11	10	12	8	10	8
	E	72	55	49	42	36	35	36	32	29	27	23	25	25
	F	13	22	26	31	35	34	36	36	40	39	33	46	33
	OBS	382	382	382	382	382	382	382	382	382	382	382	382	382
F	A	0	0	0	0	0	0	0	1	1	2	2	2	3
	B	2	4	3	2	2	3	4	4	6	8	12	8	13
	C	1	1	2	2	2	2	3	5	5	7	11	9	13
	D	1	2	4	4	4	7	8	9	10	8	10	10	10
	E	9	12	12	13	16	17	17	18	21	20	21	21	21
	F	86	81	79	78	75	71	68	63	56	54	44	50	40
	OBS	610	610	610	610	610	610	610	610	610	610	610	610	610

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	5.9	18.3	11.9	10.5	20.5	32.8
TOTAL OBS	1860	109	341	222	196	382	610

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 06-07 LST
WIND SECTOR ALL

VISIBILITY CATEGORY INIT	SUBS	HOURS SUBSEQUENT 1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	72	61	49	38	30	25	17	22	21	23	22	13	19
	K	14	14	15	10	7	8	7	5	10	13	12	6	5
	L	8	11	11	13	10	9	10	11	11	6	11	10	10
	M	2	2	5	6	8	6	7	6	4	2	4	3	2
	N	3	6	10	17	19	16	14	12	8	9	7	14	7
	O	2	6	10	15	25	35	45	44	47	47	44	54	57
	OBS	195	195	195	195	195	195	195	195	195	195	195	195	195
K	J	24	22	16	12	12	11	4	8	10	14	17	6	9
	K	43	31	26	22	16	12	10	8	9	5	9	4	9
	L	11	20	22	13	13	15	13	12	12	12	9	7	9
	M	5	6	3	10	12	9	6	3	5	1	1	5	4
	N	11	10	19	20	22	25	24	16	9	12	12	14	5
	O	6	10	14	23	25	28	43	53	56	56	51	64	64
	OBS	138	138	138	138	138	138	138	138	138	138	138	138	138
L	J	9	9	14	9	6	7	8	8	11	15	10	11	10
	K	19	26	16	15	13	10	4	5	10	7	8	3	0
	L	47	26	18	19	18	16	11	13	6	11	12	14	11
	M	6	9	9	8	8	8	6	6	6	8	4	5	4
	N	11	16	22	21	21	20	21	11	12	6	8	11	9
	O	8	14	21	29	34	39	51	57	54	54	59	56	59
	OBS	140	140	140	140	140	140	140	140	140	140	140	140	140
M	J	4	2	0	4	2	8	8	12	12	14	8	14	10
	K	8	16	12	10	12	8	10	4	12	8	6	2	8
	L	34	24	28	18	20	22	10	4	6	10	6	12	8
	M	20	16	12	16	12	6	4	2	2	6	0	2	4
	N	18	26	24	20	22	20	12	12	12	6	20	16	10
	O	16	16	24	32	32	36	56	66	56	56	60	54	60
	OBS	50	50	50	50	50	50	50	50	50	50	50	50	50
N	J	4	8	6	6	5	4	6	9	10	10	12	6	8
	K	8	12	12	7	6	3	3	2	6	6	7	5	13
	L	15	13	12	15	9	9	9	9	6	8	8	8	12
	M	8	10	11	8	8	5	3	2	3	3	3	1	3
	N	35	25	24	23	28	29	18	17	12	9	13	13	12
	O	30	32	36	41	45	50	62	61	65	64	57	68	52
	OBS	155	155	155	155	155	155	155	155	155	155	155	155	155
O	J	1	2	2	2	1	1	1	2	3	5	8	4	10
	K	1	2	2	3	3	2	3	3	4	3	6	3	7
	L	2	3	4	4	5	5	4	5	5	5	6	5	6
	M	2	2	2	2	2	2	2	2	2	3	3	3	3
	N	5	8	9	8	8	7	8	7	7	7	7	8	9
	O	89	83	81	81	82	82	82	81	80	77	70	78	66
	OBS	1182	1182	1182	1182	1182	1182	1182	1182	1182	1182	1182	1182	1182

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	10.5	7.4	7.5	2.7	8.3	63.5
TOTAL OBS	1860	195	138	140	50	155	1182

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 08-09 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	65	47	33	26	19	18	18	9	22	18	18	13	18
	B	18	33	38	32	37	36	27	33	23	27	23	24	14
	C	8	12	14	24	19	17	18	9	12	6	12	9	6
	D	3	0	4	6	9	10	6	4	4	18	8	10	13
	E	1	3	4	4	4	6	8	13	17	10	15	15	18
	F	5	5	6	8	12	13	23	32	23	21	24	28	31
	OBS	78	78	78	78	78	78	78	78	78	78	78	78	78
B	A	2	4	4	4	5	5	5	6	7	11	6	4	5
	B	68	50	40	34	30	25	24	30	27	27	24	22	21
	C	18	26	29	28	28	26	19	13	16	15	17	14	16
	D	4	6	8	14	15	17	12	7	8	9	11	6	14
	E	2	6	9	9	10	13	17	14	12	10	15	19	17
	F	5	9	10	11	13	14	23	27	30	27	27	35	27
	OBS	339	339	339	339	339	339	339	339	339	339	339	339	339
C	A	1	2	1	0	1	2	3	4	3	2	3	3	5
	B	15	14	13	15	14	15	16	22	19	20	18	14	17
	C	61	51	44	32	24	20	19	17	16	17	22	15	13
	D	15	18	21	27	27	27	18	12	16	15	17	12	13
	E	4	7	7	12	19	18	19	17	18	19	13	19	24
	F	4	9	14	14	15	19	25	29	27	26	27	37	29
	OBS	241	241	241	241	241	241	241	241	241	241	241	241	241
D	A	0	1	0	0	1	2	3	4	5	6	4	2	5
	B	3	3	6	7	7	6	10	9	16	19	23	16	20
	C	11	13	13	16	17	17	14	15	12	14	11	12	11
	D	61	51	46	37	34	27	19	15	16	14	11	13	12
	E	21	23	23	29	28	30	29	25	15	17	19	15	19
	F	3	8	11	11	13	19	25	32	36	30	33	41	34
	OBS	205	205	205	205	205	205	205	205	205	205	205	205	205
E	A	0	0	0	1	1	1	1	1	3	2	3	2	1
	B	1	2	4	3	3	5	7	12	13	17	17	12	22
	C	3	5	3	5	7	5	12	9	7	8	12	5	13
	D	11	11	13	16	16	17	13	10	13	12	10	9	9
	E	69	58	51	47	43	39	29	28	29	24	22	25	15
	F	15	24	28	29	30	34	38	40	35	37	36	46	40
	OBS	350	350	350	350	350	350	350	350	350	350	350	350	350
F	A	0	0	0	0	0	0	1	2	2	2	3	2	3
	B	1	2	1	3	3	3	3	5	5	9	13	10	13
	C	0	0	1	2	2	2	4	4	7	8	10	7	14
	D	1	3	4	4	4	4	5	9	8	8	10	10	9
	E	6	9	11	13	15	17	19	21	22	21	21	22	20
	F	91	86	82	79	76	73	68	60	56	52	44	48	40
	OBS	647	647	647	647	647	647	647	647	647	647	647	647	647

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	4.2	18.2	13.0	11.0	18.8	34.8
TOTAL OBS	1860	78	339	241	205	350	647

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 08-09 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	65	49	37	30	26	20	23	22	25	25	21	13	18
	K	14	13	15	9	8	10	8	9	11	12	11	9	9
	L	12	15	12	15	11	9	12	11	5	5	10	8	8
	M	2	6	7	9	7	5	4	6	2	5	8	4	2
	N	4	9	15	14	16	19	12	7	9	11	12	7	11
	O	3	7	14	23	33	36	40	45	49	41	38	59	51
	OBS	193	193	193	193	193	193	193	193	193	193	193	193	193
K	J	15	13	11	11	11	10	6	10	15	15	11	9	14
	K	37	26	18	15	12	6	6	12	10	10	12	5	12
	L	21	17	16	14	12	12	12	12	11	11	11	15	10
	M	7	7	10	8	4	4	6	3	1	3	3	4	4
	N	12	18	20	17	21	17	15	10	8	12	15	12	14
	O	7	19	26	34	40	50	54	53	54	49	47	54	46
	OBS	156	156	156	156	156	156	156	156	156	156	156	156	156
L	J	6	5	3	4	5	6	9	11	15	15	14	6	8
	K	17	18	13	10	8	9	9	9	5	9	11	8	8
	L	37	22	18	17	20	13	11	16	13	8	11	11	12
	M	13	14	13	8	5	6	6	4	3	8	6	3	4
	N	17	22	27	28	24	23	15	10	9	12	14	11	13
	O	10	20	26	32	38	42	49	51	55	49	45	62	53
	OBS	158	158	158	158	158	158	158	158	158	158	158	158	158
M	J	3	3	1	3	4	4	10	7	4	9	14	9	14
	K	9	7	6	4	6	7	1	6	6	7	9	4	9
	L	17	16	11	13	14	14	7	12	4	4	14	9	4
	M	20	11	10	4	4	3	6	4	10	6	3	4	1
	N	39	33	31	37	30	26	19	14	9	9	10	13	10
	O	13	30	40	39	41	46	57	57	67	66	50	61	61
	OBS	70	70	70	70	70	70	70	70	70	70	70	70	70
N	J	3	3	2	2	3	2	5	6	7	9	13	9	12
	K	6	4	3	3	3	5	7	8	8	11	9	9	9
	L	8	13	12	13	12	12	11	8	10	10	12	11	9
	M	5	5	7	5	3	2	4	5	4	3	4	4	7
	N	50	38	35	31	23	21	15	16	17	12	13	10	14
	O	29	39	43	46	58	59	60	59	56	57	50	59	50
	OBS	200	200	200	200	200	200	200	200	200	200	200	200	200
O	J	0	0	1	1	1	1	1	2	3	5	7	4	8
	K	1	1	1	2	2	2	2	3	3	4	7	4	7
	L	1	2	3	3	3	3	4	3	5	6	7	4	8
	M	1	2	2	1	1	2	2	2	3	3	3	2	3
	N	5	5	5	5	5	6	6	6	6	6	10	7	10
	O	91	89	89	89	88	87	85	84	80	76	67	79	63
	OBS	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	10.4	8.4	8.5	3.8	10.8	58.2
TOTAL OBS	1860	193	156	158	70	200	1083

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 10-11 LST

CEILING CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	59	43	34	31	29	26	17	26	26	24	21	19	19
	B	28	36	41	40	33	33	36	34	28	33	22	31	17
	C	9	9	7	7	7	10	10	7	9	12	17	5	16
	D	2	2	3	9	10	10	12	12	10	7	7	7	10
	E	0	3	7	5	5	2	2	10	17	14	12	14	16
	F	2	7	7	5	16	19	22	10	10	10	21	24	22
	OBS	58	58	58	58	58	58	58	58	58	58	58	58	58
B	A	4	4	5	6	6	6	6	7	9	9	4	2	3
	B	66	51	43	37	30	29	39	38	34	33	25	23	17
	C	22	30	33	30	25	22	15	15	13	13	18	14	17
	D	4	7	11	12	16	14	8	7	11	10	17	9	13
	E	2	5	4	8	12	13	9	14	9	15	16	20	20
	F	2	3	4	6	11	15	23	19	23	20	25	32	31
	OBS	253	253	253	253	253	253	253	253	253	253	253	253	253
C	A	0	1	2	2	3	5	4	5	7	6	3	5	5
	B	12	14	14	12	13	13	22	20	17	20	13	17	13
	C	63	48	36	29	24	22	20	16	18	18	20	9	16
	D	15	21	23	27	23	17	9	14	11	12	13	13	13
	E	4	7	13	15	17	20	15	15	17	21	18	17	20
	F	5	9	12	15	20	23	29	30	27	23	33	39	33
	OBS	265	265	265	265	265	265	265	265	265	265	265	265	265
D	A	0	0	0	0	0	0	1	4	5	5	2	4	3
	B	4	6	7	8	8	8	13	13	15	22	10	13	13
	C	11	10	13	15	14	16	13	12	17	13	15	12	15
	D	65	56	46	36	33	31	19	22	16	16	15	14	17
	E	14	21	25	27	26	23	26	18	17	16	19	16	19
	F	6	7	9	14	19	22	28	31	31	28	39	41	34
	OBS	223	223	223	223	223	223	223	223	223	223	223	223	223
E	A	1	0	1	1	1	1	1	2	2	4	4	4	3
	B	1	2	2	2	5	7	9	11	16	16	14	14	13
	C	2	3	6	6	6	7	9	9	9	14	13	10	15
	D	9	14	16	16	15	14	13	12	12	7	12	10	10
	E	73	62	55	48	41	39	35	32	28	27	22	24	18
	F	14	18	20	27	32	33	34	34	33	32	36	38	40
	OBS	347	347	347	347	347	.17	347	347	347	347	347	347	347
F	A	0	0	0	0	0	1	1	2	2	3	1	2	2
	B	1	1	2	3	3	3	5	5	8	9	9	11	10
	C	1	1	1	1	1	3	3	6	7	9	12	8	13
	D	2	4	3	4	5	4	7	7	7	9	11	10	11
	E	7	10	13	16	17	17	19	20	22	20	18	22	19
	F	90	83	81	77	74	73	64	60	54	50	48	47	46
	OBS	714	714	714	714	714	714	714	714	714	714	714	714	714

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	3.1	13.6	14.2	12.0	18.7	38.4
TOTAL OBS	1860	58	253	265	223	347	714

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 10-11 LST
WIND SECTOR ALL

VISIBILITY CATEGORY INIT	SUBS	HOURS SUBSEQUENT 1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	61	48	42	34	34	34	37	34	36	31	25	19	16
	K	19	13	10	10	8	9	7	13	15	18	14	7	7
	L	11	13	14	11	10	11	13	9	8	3	12	6	10
	M	3	10	6	5	6	5	7	1	2	4	6	1	4
	N	3	10	13	19	19	16	10	8	7	11	7	14	13
	O	3	7	15	20	24	25	25	34	31	32	36	51	50
	OBS	134	134	134	134	134	134	134	134	134	134	134	134	134
K	J	10	12	10	9	11	11	9	13	13	13	12	10	10
	K	37	25	23	20	11	12	8	6	6	10	7	8	5
	L	22	20	17	16	17	15	21	12	9	9	11	8	10
	M	10	11	5	4	8	6	3	3	7	3	5	1	4
	N	17	18	23	23	22	21	17	13	12	9	18	8	13
	O	5	15	23	28	32	35	42	53	53	57	48	65	58
	OBS	120	120	120	120	120	120	120	120	120	120	120	120	120
L	J	3	6	6	6	5	5	8	10	13	11	8	7	8
	K	12	9	10	8	8	8	6	8	6	6	8	9	6
	L	36	32	27	21	17	16	12	11	10	10	11	13	11
	M	19	13	8	8	7	12	5	6	6	8	9	5	3
	N	20	23	19	21	22	15	16	13	13	7	21	10	20
	O	10	18	31	36	41	44	52	51	52	57	42	56	51
	OBS	154	154	154	154	154	154	154	154	154	154	154	154	154
M	J	0	2	4	2	5	2	7	8	8	8	10	6	13
	K	10	7	10	12	7	8	8	10	11	8	10	7	10
	L	19	19	17	13	13	16	14	13	10	12	12	12	12
	M	23	7	6	6	13	13	2	4	7	5	7	2	6
	N	39	49	41	31	23	22	14	7	7	8	23	13	17
	O	10	14	22	35	39	39	53	58	57	58	39	59	42
	OBS	83	83	83	83	83	83	83	83	83	83	83	83	83
N	J	1	1	2	1	2	4	7	8	14	14	9	11	7
	K	2	3	4	5	6	4	6	8	6	7	4	7	7
	L	8	11	10	9	10	12	11	9	9	10	12	5	13
	M	6	3	3	3	3	3	4	3	5	3	5	4	7
	N	53	35	26	24	22	20	15	13	11	14	22	10	16
	O	30	47	55	57	57	57	57	58	54	52	49	62	50
	OBS	230	230	230	230	230	230	230	230	230	230	230	230	230
O	J	0	0	1	1	0	1	2	3	5	6	4	5	6
	K	0	1	1	1	2	2	2	3	3	5	5	4	6
	L	1	1	2	2	2	3	3	4	5	6	6	5	6
	M	1	1	1	1	1	1	2	2	3	2	4	3	4
	N	3	4	5	5	5	5	6	6	6	7	9	7	10
	O	95	93	91	90	89	88	86	82	78	75	72	77	68
	OBS	1139	1139	1139	1139	1139	1139	1139	1139	1139	1139	1139	1139	1139

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	7.2	6.5	8.3	4.5	12.4	61.2
TOTAL OBS	1860	134	120	154	83	230	1139

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 12-13 LST

CEILING CATEGORY / HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	68	63	55	39	37	32	24	32	42	34	24	21	13
	B	26	29	29	37	37	34	39	29	21	45	37	29	26
	C	3	5	0	3	8	3	3	5	5	8	11	5	13
	D	0	3	8	5	3	8	8	8	11	0	11	16	13
	E	0	0	3	3	3	8	13	16	5	5	5	13	11
	F	3	0	5	13	13	16	13	11	16	8	13	16	24
	OBS	38	38	38	38	38	38	38	38	38	38	38	38	38
B	A	1	6	8	10	10	9	10	12		11	5	7	3
	B	70	56	43	36	38	44	39	35	36	31	21	21	16
	C	20	24	23	22	21	17	18	14	14	13	21	14	13
	D	3	9	11	12	10	9	9	13	13	13	15	11	13
	E	1	3	7	9	9	8	6	7	10	16	19	18	27
	F	2	2	8	11	11	13	18	19	18	16	21	29	28
	OBS	219	219	219	219	219	219	219	219	219	219	219	219	219
C	A	1	2	2	3	4	3	5	6	5	8	2	4	2
	B	10	12	15	17	18	24	29	25	28	31	16	23	12
	C	61	44	34	29	28	25	16	18	16	12	22	12	22
	D	14	22	23	17	16	13	12	11	12	17	14	10	17
	E	6	9	10	15	16	12	13	13	17	13	16	20	21
	F	7	11	17	18	18	22	24	26	22	20	31	31	27
	OBS	249	249	248	243	249	249	249	249	249	249	249	249	249
D	A	0	1	1	0	1	1	3	4	6	3	2	5	2
	B	3	5	6	7	9	10	13	15	21	21	13	15	13
	C	12	12	13	17	18	16	15	14	14	13	12	14	14
	D	65	48	43	37	30	26	21	19	17	18	20	12	15
	E	14	21	22	19	20	20	22	20	17	18	20	18	21
	F	5	13	16	20	22	26	26	26	25	26	33	36	34
	OBS	276	276	276	276	276	276	276	276	276	276	276	276	276
E	A	0	0	0	1	1	1	2	3	3	5	2	4	2
	B	1	2	4	6	7	7	10	12	16	14	11	15	12
	C	2	3	5	7	9	8	8	11	11	15	8	12	12
	D	16	14	14	12	12	15	13	10	10	6	13	7	15
	E	76	61	52	48	41	38	38	34	31	30	28	23	19
	F	5	18	25	27	29	31	29	31	29	31	38	38	39
	OBS	367	367	367	367	367	367	367	367	367	367	367	367	367
F	A	0	0	0	0	0	1	1	1	2	3	0	3	1
	B	1	1	2	2	2	3	4	5	8	11	6	9	8
	C	0	0	0	1	3	3	4	6	9	10	11	8	11
	D	1	2	2	2	2	3	6	6	7	8	11	10	14
	E	7	13	15	15	17	19	19	21	19	21	18	21	18
	F	90	84	81	79	76	71	66	60	55	48	50	49	49
	OBS	711	711	711	711	711	711	711	711	711	711	711	711	711

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	2.0	11.8	13.4	14.8	19.7	38.2
TOTAL OBS	1360	38	219	249	276	367	711

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 12-13 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	73	56	48	41	44	43	33	36	35	34	1[illegible]	18	7
	K	11	14	11	14	12	7	11	11	18	14	4	4	7
	L	4	9	6	7	10	14	12	6	5	4	11	10	11
	M	2	1	6	3	3	5	2	1	5	6	7	5	5
	N	5	9	18	19	11	7	11	10	8	8	16	11	12
	O	4	10	10	15	19	23	30	35	29	33	44	52	57
	OBS	97	97	97	97	97	97	97	97	97	97	97	97	97
K	J	10	12	13	17	14	17	13	26	18	20	8	15	13
	K	45	25	20	17	15	8	14	10	10	5	8	10	5
	L	30	30	20	14	18	15	14	7	11	15	12	8	5
	M	2	10	4	10	5	5	0	0	2	1	4	6	4
	N	10	12	21	13	11	19	8	8	11	10	20	7	19
	O	4	12	21	30	37	36	50	49	49	49	48	54	55
	OBS	84	84	84	84	84	84	84	84	84	84	84	84	84
L	J	3	4	5	6	8	10	12	16	11	12	9	13	5
	K	13	17	10	10	6	5	10	5	7	10	4	6	6
	L	48	30	29	24	22	20	17	17	16	12	14	9	8
	M	10	9	12	13	14	12	8	10	6	2	7	3	6
	N	15	18	16	19	16	13	10	7	11	9	14	8	17
	O	10	22	28	28	34	39	44	46	50	56	52	61	59
	OBS	145	145	145	145	145	145	145	145	145	145	145	145	145
M	J	0	1	6	8	6	6	15	9	12	10	4	12	6
	K	13	13	12	14	19	10	13	7	6	10	7	7	4
	L	21	19	18	18	15	24	7	19	9	12	10	12	10
	M	16	9	9	12	6	4	7	4	7	3	3	1	3
	N	31	30	24	15	16	21	10	10	15	12	25	9	21
	O	18	27	31	33	37	34	46	49	51	52	49	58	55
	OBS	67	67	67	66	67	67	67	67	67	67	67	67	67
N	J	1	1	2	3	5	6	9	11	8	12	6	11	6
	K	2	3	4	3	5	7	8	9	12	8	7	10	3
	L	6	7	10	14	13	12	10	8	7	11	10	7	11
	M	6	5	7	6	6	3	5	6	3	5	4	5	5
	N	56	46	36	30	24	22	17	12	14	12	24	9	17
	O	28	38	42	43	48	50	50	54	57	52	49	57	58
	OBS	236	236	236	236	236	236	236	236	236	236	236	236	236
O	J	0	0	0	1	1	2	3	5	6	7	3	7	4
	K	0	1	1	1	2	1	3	3	6	6	4	4	4
	L	1	1	1	3	3	2	3	4	5	6	6	5	7
	M	0	1	1	1	1	1	2	2	2	2	3	3	3
	N	3	4	5	5	5	6	6	6	7	7	9	6	10
	O	96	93	91	89	88	87	84	80	74	71	75	75	71
	OBS	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	5.2	4.5	7.8	3.6	12.7	66.[illegible]
TOTAL OBS	1860	97	84	145	67	236	1[illegible]1

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 14-15 LST

CEILING CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	79	58	49	42	28	30	35	35	26	23	23	16	9
	B	9	26	33	28	40	33	26	26	42	37	30	33	19
	C	5	2	2	9	9	9	7	7	7	9	14	12	11
	D	0	0	2	5	9	7	9	14	5	7	2	7	12
	E	2	5	5	7	5	12	12	5	5	7	12	14	9
	F	5	9	9	9	9	9	12	14	16	16	19	19	37
	OBS	43	43	43	43	43	43	43	43	43	43	43	43	43
B	A	5	7	8	8	7	6	11	12	12	10	4	7	5
	B	69	56	50	54	55	53	47	41	36	30	26	30	18
	C	13	16	21	17	16	18	14	13	13	14	15	9	11
	D	4	5	8	9	7	7	8	8	11	12	13	7	13
	E	3	5	5	4	5	5	8	10	13	13	16	14	24
	F	6	11	9	9	9	11	12	16	14	21	26	33	28
	OBS	195	195	195	195	195	195	195	195	195	195	195	195	195
C	A	0	1	2	3	4	5	8	5	8	5	4	6	5
	B	14	20	25	30	32	31	26	24	29	25	15	20	10
	C	60	44	35	29	25	22	20	19	12	19	18	16	13
	D	13	16	15	14	11	12	12	19	13	9	14	12	15
	E	7	11	13	10	12	11	13	11	15	17	16	20	19
	F	4	8	10	14	17	19	21	23	24	24	33	25	37
	OBS	215	215	216	216	216	216	216	216	216	216	216	216	216
D	A	0	1	1	1	3	3	4	6	7	1	1	5	1
	B	4	5	8	10	12	13	14	22	19	20	8	17	8
	C	7	17	21	19	17	18	19	14	20	16	13	14	15
	D	69	48	34	32	29	26	24	23	17	19	19	13	21
	E	12	14	18	19	18	16	17	14	17	17	26	18	18
	F	8	15	18	19	22	25	22	21	20	26	33	34	37
	OBS	269	269	269	269	269	269	269	269	269	269	269	269	269
E	A	0	1	1	1	1	2	2	3	3	4	2	4	2
	B	1	2	3	5	7	7	11	14	15	13	8	17	9
	C	3	6	8	8	8	8	9	10	13	12	9	12	9
	D	9	11	12	12	10	11	11	10	9	9	13	8	13
	E	72	59	51	44	41	40	33	31	27	27	25	20	24
	F	15	21	25	30	33	31	33	33	33	35	42	39	42
	OBS	403	403	403	403	403	403	403	403	403	403	403	403	403
F	A	0	0	0	1	1	1	1	2	3	3	1	3	1
	B	0	0	1	2	3	3	4	8	10	13	5	13	8
	C	0	1	2	2	2	2	5	8	10	11	9	9	10
	D	1	2	3	3	4	4	6	6	7	9	15	13	12
	E	8	12	13	16	17	19	19	19	20	17	21	19	21
	F	91	85	81	76	73	70	65	57	50	47	49	44	47
	OBS	734	734	734	734	734	734	734	734	734	734	734	734	734

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	2.3	10.5	11.6	14.5	21.7	39.5
TOTAL OBS	1860	43	195	216	269	403	734

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 14-15 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	73	65	59	58	47	40	42	45	31	33	21	21	10
	K	12	14	15	8	8	9	9	10	15	10	5	8	9
	L	6	5	6	10	15	18	8	4	1	5	10	12	10
	M	1	4	5	4	4	3	1	5	4	4	3	5	3
	N	6	8	6	4	6	12	10	10	10	18	17	8	8
	O	1	4	8	17	19	19	29	26	38	29	45	47	60
	OBS	78	78	78	78	78	78	78	78	78	78	78	78	78
K	J	15	19	15	13	14	15	28	21	21	22	5	19	6
	K	41	33	27	14	8	16	5	7	7	8	7	7	8
	L	24	19	28	35	34	20	19	14	9	12	12	7	5
	M	4	6	6	7	7	8	4	5	4	2	4	4	7
	N	8	14	7	8	13	5	4	7	11	11	11	13	9
	O	8	9	16	22	24	35	41	46	48	45	62	51	65
	OBS	85	85	85	85	85	85	85	85	85	85	85	85	85
L	J	5	7	8	10	13	11	12	13	20	18	10	10	7
	K	9	11	12	11	8	12	8	10	4	12	5	10	3
	L	51	43	33	23	23	15	18	13	12	10	8	6	8
	M	15	14	14	14	11	12	12	8	3	5	6	3	3
	N	17	17	17	16	14	15	12	14	8	13	14	13	14
	O	3	9	17	26	31	36	39	43	53	43	58	58	67
	OBS	120	120	120	120	120	120	120	120	120	120	120	120	120
M	J	0	8	10	10	8	10	20	16	14	18	2	14	6
	K	6	2	2	2	12	6	14	14	8	20	12	6	4
	L	26	20	22	26	18	28	22	14	12	10	12	12	8
	M	26	18	20	12	10	4	10	8	8	4	6	6	8
	N	32	28	20	18	20	18	6	14	8	10	20	2	24
	O	10	24	26	32	32	34	28	34	50	38	48	60	50
	OBS	50	50	50	50	50	50	50	50	50	50	50	50	50
N	J	0	1	6	9	7	9	11	13	12	12	4	10	4
	K	5	6	5	4	6	9	11	12	13	12	9	12	6
	L	7	14	13	14	16	16	8	13	14	12	5	11	8
	M	9	7	5	5	4	4	5	5	5	6	3	5	1
	N	58	40	32	26	22	21	14	12	9	17	26	10	22
	O	21	32	40	43	44	42	52	45	48	40	52	52	59
	OBS	220	220	221	221	221	221	221	221	221	221	221	221	221
O	J	0	1	1	2	2	3	3	5	7	7	3	7	4
	K	0	1	1	2	2	3	3	5	6	7	4	5	4
	L	0	2	2	2	2	2	4	5	6	8	6	6	6
	M	1	1	1	1	1	2	2	3	2	3	2	3	3
	N	4	4	5	6	6	5	7	7	7	10	9	8	9
	O	95	92	90	88	87	86	81	76	73	66	77	71	75
	OBS	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	4.2	4.6	6.5	2.7	11.9	70.2
TOTAL OBS	1860	78	85	120	50	221	1306

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 16-17 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	78	59	43	37	35	35	29	29	29	22	18	16	12
	B	16	35	41	33	31	31	27	27	35	27	12	20	10
	C	4	6	8	12	12	10	16	10	8	6	14	12	8
	D	2	0	6	14	14	14	10	8	6	8	2	6	20
	E	0	0	2	4	8	8	8	14	12	14	14	14	22
	F	0	0	0	0	0	2	10	12	10	22	39	31	27
	OBS	49	49	49	49	49	49	49	49	49	49	49	49	49
B	A	5	6	7	10	8	10	13	14	11	8	6	8	7
	B	75	66	65	59	58	54	42	42	32	29	27	32	16
	C	11	15	14	15	16	19	13	14	15	17	14	13	13
	D	7	7	6	7	10	7	14	12	16	15	12	9	12
	E	1	3	5	5	4	5	10	12	13	12	13	15	17
	F	2	3	4	4	4	6	8	7	12	18	28	22	34
	OBS	189	189	189	189	189	189	189	189	189	189	189	189	189
C	A	0	0	1	2	2	3	5	3	5	1	1	5	1
	B	16	26	29	29	30	28	26	25	23	14	14	21	11
	C	66	47	40	35	29	27	22	22	17	23	15	15	13
	D	9	16	14	14	17	14	17	17	18	15	13	9	17
	E	6	6	8	10	10	13	16	15	18	22	20	21	19
	F	3	4	8	10	11	14	14	18	19	26	37	30	38
	OBS	203	203	203	203	203	203	203	203	203	203	203	203	203
D	A	1	1	2	2	3	2	3	6	3	2	3	7	3
	B	5	9	13	14	13	16	21	18	21	15	11	18	10
	C	19	21	18	17	16	15	18	22	19	20	11	16	13
	D	57	40	33	29	28	29	22	16	17	17	16	11	12
	E	12	17	19	20	22	20	21	20	16	18	22	15	23
	F	6	12	16	18	19	18	15	17	23	29	36	32	39
	OBS	232	232	232	232	232	232	232	232	232	232	232	232	232
E	A	0	0	1	2	2	2	3	3	3	3	2	3	2
	B	1	3	5	7	7	7	11	13	17	11	9	19	9
	C	3	3	3	5	7	8	12	11	12	13	8	12	7
	D	8	12	13	13	13	13	8	11	7	9	10	5	14
	E	74	59	52	45	41	39	33	31	30	26	28	26	21
	F	14	23	26	29	30	30	33	31	32	38	44	34	46
	OBS	393	393	393	393	393	393	393	393	393	393	393	393	393
F	A	1	1	1	1	2	2	3	4	4	2	1	4	2
	B	1	2	3	3	4	5	7	11	14	9	6	13	8
	C	1	2	2	3	3	3	5	8	9	11	10	11	11
	D	1	2	2	2	3	4	6	5	7	11	13	11	10
	E	7	11	13	16	18	17	17	18	18	16	20	21	21
	F	89	82	79	75	71	69	62	55	48	51	51	40	49
	OBS	793	793	793	793	793	793	793	793	793	793	793	793	792

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	2.6	10.2	10.9	12.5	21.1	42.7
TOTAL OBS	1859	49	189	203	232	393	793

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 16-17 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	78	70	60	52	51	54	44	38	38	27	26	21	17
	K	13	11	9	9	7	7	8	13	9	11	9	20	4
	L	3	7	13	17	12	8	8	4	9	12	7	4	7
	M	0	2	1	3	4	3	1	2	4	1	2	6	0
	N	3	4	4	6	11	10	7	7	10	12	11	2	16
	O	2	6	12	13	15	18	33	35	29	36	44	46	56
	OBS	89	89	89	89	89	89	89	89	89	89	89	89	89
K	J	16	13	10	5	12	10	19	16	19	16	8	18	6
	K	48	25	13	23	22	17	13	12	9	12	9	13	9
	L	27	40	44	31	23	27	22	19	10	10	5	6	8
	M	1	5	13	13	5	5	6	5	3	3	3	3	0
	N	6	9	10	12	12	6	8	6	18	21	14	10	13
	O	1	8	9	16	26	34	31	42	40	39	61	49	64
	OBS	77	77	77	77	77	77	77	77	77	77	77	77	77
L	J	8	12	13	16	17	17	13	11	15	21	9	17	8
	K	14	8	16	13	11	11	11	9	15	6	8	5	5
	L	49	40	28	28	24	19	14	12	15	9	15	9	8
	M	14	12	8	5	6	8	10	4	4	5	8	8	5
	N	11	15	15	15	15	15	8	12	6	18	10	10	9
	O	5	13	21	23	26	30	44	52	45	40	50	51	63
	OBS	131	131	131	131	131	131	131	131	131	131	131	131	131
M	J	0	3	11	13	14	13	19	16	19	6	5	3	5
	K	5	6	6	11	16	16	5	11	5	5	2	8	9
	L	20	17	20	17	6	9	3	14	13	19	8	11	6
	M	28	19	13	13	13	5	16	3	5	5	9	2	2
	N	23	20	16	5	8	14	16	13	9	19	11	14	11
	O	19	30	34	42	44	44	42	44	50	47	66	63	67
	OBS	64	64	64	64	64	64	64	64	64	64	64	64	64
N	J	3	5	9	8	9	10	15	13	13	8	7	9	4
	K	4	6	5	11	11	9	9	9	10	8	4	9	4
	L	11	8	10	7	9	10	10	9	9	9	8	8	10
	M	8	6	4	3	2	3	5	5	5	5	3	2	3
	N	44	34	26	25	21	19	12	11	14	19	20	14	15
	O	31	42	46	46	48	49	47	54	48	51	58	59	60
	OBS	194	194	194	194	194	194	194	194	194	194	194	194	194
O	J	0	1	1	1	2	2	5	6	7	4	2	8	4
	K	0	1	1	2	3	3	3	5	7	5	3	5	3
	L	1	1	2	2	2	3	4	5	8	7	6	6	6
	M	1	1	1	2	2	2	3	2	3	5	3	2	3
	N	4	5	6	5	5	6	6	7	8	10	9	7	9
	O	95	91	89	88	86	85	78	74	68	68	76	71	75
	OBS	1304	1304	1304	1304	1304	1304	1304	1304	1304	1304	1304	1304	1303

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	4.8	4.1	7.0	3.4	10.4	70.1
TOTAL OBS	1859	89	77	121	64	194	1304

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 18-19 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	62	50	50	44	44	44	37	37	19	19	23	17	21
	B	27	31	27	29	23	21	25	27	29	19	21	23	15
	C	4	4	6	10	8	9	17	8	8	15	12	13	6
	D	4	10	12	10	15	17	10	10	13	8	4	8	13
	E	0	2	4	6	6	6	8	10	8	10	12	21	19
	F	4	3	2	2	4	4	4	10	23	29	29	17	25
	OBS	52	52	52	52	52	52	52	52	52	52	52	52	52
B	A	6	8	10	12	14	13	9	11	5	5	3	7	6
	B	82	72	66	61	53	49	46	36	28	26	25	27	21
	C	7	11	13	13	16	16	15	14	18	18	15	11	11
	D	2	5	5	5	8	7	12	16	15	13	8	8	8
	E	2	3	4	6	6	9	11	14	19	19	12	20	21
	F	1	2	2	2	3	6	6	8	15	14	37	27	33
	OBS	241	241	241	241	241	241	241	241	241	241	241	241	241
C	A	1	3	1	2	2	3	5	3	1	0	1	5	3
	B	20	23	26	24	26	22	25	24	21	14	17	24	17
	C	65	53	43	38	32	29	28	24	26	20	14	15	10
	D	8	9	15	16	15	17	15	16	14	18	12	10	13
	E	5	7	8	9	11	14	12	15	14	18	19	18	19
	F	2	4	6	10	14	14	14	16	23	29	36	27	38
	OBS	201	201	201	201	201	201	201	201	201	201	201	201	201
D	A	0	1	2	1	2	2	5	4	3	3	2	7	4
	B	4	7	7	10	12	18	19	23	15	9	14	23	6
	C	12	16	17	19	20	18	15	14	19	18	11	10	14
	D	61	46	41	35	28	24	21	17	15	17	14	15	20
	E	13	18	21	21	21	21	22	24	21	21	20	19	17
	F	10	13	12	14	16	17	19	19	27	31	39	26	40
	OBS	204	204	204	204	204	204	204	204	204	204	204	204	204
E	A	0	1	1	1	1	2	1	2	3	1	2	4	2
	B	1	4	5	6	6	6	8	16	15	10	11	16	10
	C	1	1	2	4	7	8	11	10	11	13	8	13	10
	D	8	13	17	15	14	14	13	9	12	13	12	8	11
	E	77	61	53	48	45	43	33	29	26	27	27	27	23
	F	12	20	23	25	27	27	32	34	33	36	40	32	43
	OBS	379	379	379	379	379	379	379	379	379	379	379	379	379
F	A	0	1	1	1	2	2	3	5	3	1	2	4	1
	B	1	1	2	3	4	5	10	11	10	8	8	16	12
	C	0	1	2	2	3	4	6	9	10	9	9	10	9
	D	1	1	1	3	3	4	5	7	10	13	10	11	8
	E	7	12	15	15	15	15	17	19	15	17	21	19	20
	F	91	84	80	76	73	69	59	50	52	53	49	39	50
	OBS	783	783	783	783	783	783	783	783	783	783	783	783	783

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	2.8	13.0	10.8	11.0	20.4	42.1
TOTAL OBS	1860	52	241	201	204	379	783

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 18-19 LST
WIND SECTOR ALL

VISIBILITY CATEGORY INIT	SUBS	HOURS SUBSEQUENT 1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	77	63	62	62	58	56	44	44	35	23	28	23	21
	K	10	13	12	13	15	13	22	12	13	9	5	7	3
	L	8	13	13	12	10	7	4	11	9	13	10	9	10
	M	1	3	4	2	2	1	4	6	4	5	1	4	2
	N	2	6	5	4	7	9	6	4	12	14	13	2	6
	O	3	2	4	8	8	13	20	24	27	36	44	55	58
	OBS	112	112	112	112	112	112	112	112	112	112	112	112	112
K	J	10	14	14	13	19	22	16	19	16	11	14	13	10
	K	40	37	33	32	22	22	16	14	8	8	3	13	10
	L	32	19	16	14	11	8	13	11	13	6	10	14	10
	M	6	8	5	3	8	8	2	3	6	5	5	3	3
	N	8	6	6	8	5	8	16	17	21	27	25	17	11
	O	5	16	25	30	35	32	38	35	37	43	43	40	57
	OBS	63	63	63	63	63	63	63	63	63	63	63	63	63
L	J	8	8	12	14	16	19	15	18	20	14	12	18	14
	K	15	21	15	12	12	13	10	4	12	9	7	8	5
	L	52	38	32	27	28	22	21	17	9	6	13	9	8
	M	8	10	8	8	9	11	8	4	5	6	3	6	2
	N	13	12	17	20	13	11	13	12	18	18	12	9	13
	O	5	11	16	19	22	24	34	45	35	47	53	50	58
	OBS	130	130	130	130	130	130	130	130	130	130	130	130	130
M	J	7	5	13	11	7	9	13	9	11	4	4	11	2
	K	2	11	15	13	16	13	15	20	18	9	5	9	4
	L	25	20	13	9	13	9	5	5	11	18	20	13	7
	M	31	15	7	9	7	7	5	7	11	5	2	4	2
	N	18	25	22	25	22	22	22	13	9	13	11	5	15
	O	16	24	31	33	35	40	40	45	40	51	58	58	71
	OBS	55	55	55	55	55	55	55	55	55	55	55	55	55
N	J	2	6	5	8	9	12	10	7	9	4	5	9	3
	K	4	6	8	6	7	6	8	9	7	2	4	10	6
	L	9	8	8	10	9	12	8	12	8	13	8	8	7
	M	5	5	4	4	6	6	3	4	8	3	3	3	3
	N	52	32	28	23	15	11	17	13	22	21	13	9	15
	O	28	42	46	49	54	54	54	54	46	56	66	60	66
	OBS	179	179	179	179	179	179	179	179	179	179	179	179	179
O	J	0	1	1	1	2	3	5	7	6	3	3	9	4
	K	1	1	2	2	2	2	5	6	6	4	2	6	2
	L	1	2	2	3	3	4	5	6	8	6	5	7	6
	M	1	1	2	2	2	2	2	2	3	3	3	2	3
	N	3	4	4	5	6	6	7	7	11	11	8	9	9
	O	94	91	89	87	85	83	76	72	67	74	78	67	75
	OBS	1321	1321	1321	1321	1321	1321	1321	1321	1321	1321	1321	1321	1321

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	6.0	3.4	7.0	3.0	9.6	71.0
TOTAL OBS	1860	112	63	130	55	179	1321

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 20-21 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	75	66	54	46	36	36	31	25	20	13	5	20	15
	B	20	25	25	26	38	39	34	31	26	18	23	13	23
	C	0	3	7	11	11	11	7	8	10	16	7	15	8
	D	2	0	5	7	7	5	11	10	11	11	8	8	11
	E	0	2	2	3	5	5	8	11	10	8	10	10	16
	F	3	5	8	7	3	3	8	15	23	33	48	34	26
	OBS	61	61	61	61	61	61	61	61	61	61	61	61	61
B	A	4	7	11	10	11	10	12	6	5	5	5	7	6
	B	78	66	56	51	43	41	35	32	25	22	28	23	20
	C	9	13	16	15	16	17	18	17	19	18	12	14	12
	D	5	6	8	11	11	14	13	15	15	14	8	12	11
	E	3	5	6	8	12	13	14	13	19	15	16	18	19
	F	1	3	3	5	6	6	8	17	16	25	32	27	32
	OBS	272	272	272	272	272	272	272	272	272	272	272	272	272
C	A	1	1	2	4	3	3	4	5	1	1	3	3	4
	B	15	23	27	26	32	33	34	30	19	19	22	19	16
	C	68	52	42	36	27	25	21	20	24	17	15	13	16
	D	9	14	16	14	17	18	15	14	17	21	9	18	10
	E	5	6	7	11	12	10	16	18	17	15	19	20	17
	F	2	3	7	9	9	11	11	13	21	28	33	27	36
	OBS	183	183	183	183	183	183	183	183	183	183	183	183	183
D	A	1	1	1	3	4	5	5	2	2	4	3	5	7
	B	3	6	7	10	13	13	14	15	11	7	12	20	9
	C	8	15	17	18	21	18	19	21	19	12	10	16	9
	D	70	51	40	34	27	30	25	17	21	23	14	13	13
	E	14	17	21	21	20	18	18	17	17	20	20	21	22
	F	4	9	14	14	15	17	20	27	30	33	40	25	40
	OBS	183	183	183	183	183	183	183	183	183	183	183	183	183
E	A	1	1	1	1	2	2	3	2	1	1	3	3	1
	B	2	4	5	6	7	11	13	16	10	6	11	15	13
	C	2	4	6	8	10	11	14	11	14	11	9	16	7
	D	10	14	15	14	14	13	11	12	12	13	9	8	7
	E	75	62	54	49	46	38	32	28	26	31	28	21	23
	F	11	15	21	22	22	26	28	29	37	38	41	36	49
	OBS	385	385	385	385	385	385	385	385	385	385	385	385	385
F	A	1	1	1	2	2	3	4	3	1	1	3	3	2
	B	1	2	3	4	6	7	10	10	7	6	10	16	13
	C	1	1	2	3	4	4	7	10	9	7	9	11	9
	D	1	1	2	2	3	4	4	6	10	12	10	10	9
	E	7	10	12	14	13	14	17	16	18	21	20	17	20
	F	90	85	80	75	72	68	58	53	56	52	49	42	47
	OBS	776	776	776	776	776	776	776	776	776	776	776	776	776

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	3.3	14.6	9.8	9.8	20.7	41.7
TOTAL OBS	1860	61	272	183	183	385	776

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 20-21 LST
WIND SECTOR ALL

VISIBILITY CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
	J	76	67	59	61	56	49	40	43	24	20	19	26	20
	K	11	14	12	12	13	18	11	11	11	7	9	10	6
	L	7	10	11	9	6	5	11	7	11	10	12	7	11
	M	2	1	4	2	2	4	5	6	4	5	2	5	4
	N	4	3	5	5	8	5	5	6	15	13	8	11	5
	O	0	6	9	11	15	19	27	27	34	45	50	41	53
	OBS	114	114	114	114	114	114	114	114	114	114	114	114	114
K	J	19	26	32	36	33	24	17	20	14	9	13	18	15
	K	49	34	28	18	20	19	21	15	5	7	4	8	10
	L	19	21	20	16	13	18	11	11	14	9	12	11	11
	M	3	5	5	8	9	6	6	7	8	6	6	5	7
	N	4	8	7	11	8	13	13	16	21	27	13	13	9
	O	5	6	8	10	16	18	29	29	37	42	51	44	47
	OBS	98	98	98	98	98	98	98	98	98	98	98	98	98
L	J	6	10	12	12	14	14	21	18	14	10	13	15	11
	K	18	18	17	18	14	14	14	17	11	5	12	6	9
	L	46	30	25	20	23	21	16	14	11	12	10	10	10
	M	9	8	10	10	12	10	4	2	6	5	3	5	2
	N	10	14	12	10	7	11	6	17	20	18	9	14	6
	O	10	21	25	30	30	30	38	32	38	50	53	50	62
	OBS	125	125	125	125	125	125	125	125	125	125	125	125	125
M	J	6	6	6	8	6	9	15	17	9	9	8	9	2
	K	6	6	11	13	15	17	13	15	13	6	9	11	2
	L	23	23	19	17	17	13	13	21	4	6	15	4	6
	M	30	13	9	8	9	4	2	6	6	2	2	4	2
	N	17	17	13	11	19	19	15	8	21	23	11	23	17
	O	19	36	42	43	34	38	42	34	47	55	55	49	72
	OBS	53	53	53	53	53	53	53	53	53	53	53	53	53
N	J	3	3	7	8	10	10	10	10	5	4	6	13	3
	K	5	6	6	5	5	6	12	13	5	12	9	7	5
	L	6	11	11	13	11	10	3	10	14	9	10	7	6
	M	8	8	10	10	11	10	5	7	5	2	5	3	5
	N	50	38	31	22	21	25	13	16	24	18	14	15	11
	O	28	34	36	41	42	39	52	43	47	55	56	55	69
	OBS	153	153	153	153	153	153	153	153	153	153	153	153	153
O	J	0	1	2	3	4	4	6	6	2	2	4	8	4
	K	1	1	1	2	2	4	4	6	4	3	4	3	7
	L	1	1	2	3	3	4	5	7	6	5	5	9	6
	M	1	1	1	1	2	2	2	3	4	2	3	3	2
	N	3	4	5	5	5	6	7	10	11	9	7	10	8
	O	94	91	89	86	83	80	76	68	72	79	78	62	75
	OBS	1317	1317	1317	1317	1317	1317	1317	1317	1317	1317	1317	1317	1317

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	6.1	5.3	6.7	2.8	8.2	70.8
TOTAL OBS	1860	114	98	125	53	153	1317

GLOBAL CLIMATOLOGY BRANCH
USAFETAC
AIR WEATHER SERVICE/MAC

STATION 24114
FAIRCHILD AFB WA
POR 6/49-5/79
HOUR 22-23 LST

CEILING CATEGORY — HOURS SUBSEQUENT

INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
A	A	78	63	44	41	41	36	41	25	16	12	19	11	11
	B	18	26	33	38	33	30	29	29	19	15	18	19	23
	C	1	5	7	5	10	10	5	8	21	14	5	14	7
	D	0	3	8	10	7	8	3	5	8	11	10	11	10
	E	1	3	8	5	8	12	15	16	8	15	21	18	18
	F	1	0	0	0	1	4	7	16	27	33	27	27	32
	OBS	73	73	73	73	73	73	73	73	73	73	73	73	73
B	A	6	8	11	9	7	10	6	3	4	6	5	6	8
	B	73	63	54	52	51	47	38	27	27	21	30	19	20
	C	12	15	16	15	16	16	14	20	20	15	9	13	10
	D	4	6	8	11	11	9	14	14	11	9	9	13	13
	E	3	5	7	7	10	12	16	17	17	17	15	19	17
	F	3	4	4	5	6	6	12	19	23	32	31	30	33
	OBS	275	275	275	275	275	275	275	275	275	275	275	275	275
C	A	4	3	3	3	3	3	3	2	3	1	3	4	5
	B	13	20	26	26	28	27	32	23	15	15	22	11	16
	C	66	52	40	34	31	30	23	25	20	15	13	19	13
	D	9	12	14	15	16	18	17	13	18	15	11	14	13
	E	5	9	11	11	11	12	12	20	20	21	18	24	16
	F	3	4	6	11	12	10	12	17	23	33	33	29	37
	OBS	186	186	186	186	186	186	186	186	186	186	186	186	186
D	A	0	1	3	4	5	6	6	4	3	3	2	3	3
	B	6	10	11	13	14	16	20	12	7	11	15	13	15
	C	12	16	21	23	24	25	21	26	19	14	14	15	10
	D	65	50	42	36	30	25	20	21	30	23	18	14	13
	E	12	18	18	17	17	16	14	14	15	17	15	18	23
	F	5	4	4	6	8	12	18	22	25	32	35	36	36
	OBS	201	201	201	201	201	201	201	201	201	201	201	201	201
E	A	0	0	0	2	2	0	2	2	0	1	2	2	3
	B	2	3	6	8	9	8	10	8	6	5	9	10	9
	C	2	5	6	6	8	11	13	11	9	10	11	17	9
	D	9	10	11	11	11	11	9	14	17	14	10	10	12
	E	75	61	53	46	43	39	36	27	29	29	28	21	24
	F	12	21	24	27	28	30	30	38	39	41	40	40	43
	OBS	376	376	376	376	376	376	376	376	376	376	376	376	376
F	A	1	[illegible]	2	2	3	3	3	2	1	1	3	2	3
	B	1	2	4	5	7	8	11	7	7	7	10	12	15
	C	1	2	3	4	4	5	7	9	8	8	8	13	9
	D	1	1	2	4	4	3	6	8	10	9	9	11	7
	E	6	11	12	12	15	17	17	16	21	20	20	17	20
	F	90	83	78	73	68	63	55	58	54	55	50	45	47
	OBS	749	749	749	749	749	749	749	749	749	749	749	749	749

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	3.9	14.8	10.0	10.8	20.2	40.3
TOTAL OBS	1860	73	275	186	201	376	749

CONDITIONAL CLIMATOLOGY
MONTH JANUARY
HOUR 22-23 LST
WIND SECTOR ALL

VISIBILITY CATEGORY		HOURS SUBSEQUENT												
INIT	SUBS	1	2	3	4	5	6	9	12	15	18	24	36	48
J	J	79	76	66	60	54	47	48	33	22	25	27	21	15
	K	10	9	14	16	19	19	10	10	7	7	7	9	8
	L	8	9	4	4	5	7	13	17	12	12	8	13	13
	M	0	1	3	1	1	4	2	4	4	1	1	4	3
	N	2	4	6	6	6	6	7	13	17	11	10	13	11
	O	1	2	7	13	15	19	20	24	38	43	47	40	50
	OBS	135	135	135	135	135	135	135	135	135	134	135	135	135
K	J	17	27	27	20	17	19	21	18	7	4	15	14	15
	K	54	37	28	31	25	22	21	14	3	4	15	9	11
	L	15	13	16	9	15	14	12	12	13	17	5	13	8
	M	3	6	9	14	7	8	3	5	7	7	4	7	4
	N	8	8	7	9	15	11	13	21	26	17	12	6	13
	O	3	8	12	17	21	26	31	31	43	51	49	51	49
	OBS	95	95	95	95	95	95	95	95	95	95	95	95	95
L	J	9	10	11	10	10	17	17	12	10	10	17	8	12
	K	10	17	17	20	22	13	17	11	7	7	6	11	7
	L	47	36	32	29	21	20	22	10	16	11	10	10	6
	M	10	10	8	9	5	5	4	6	3	5	3	4	4
	N	13	11	11	11	11	10	11	24	17	8	9	17	7
	O	10	17	20	23	31	35	30	37	48	58	55	50	63
	OBS	115	115	115	115	115	115	115	115	115	115	115	115	115
M	J	7	7	7	7	9	11	15	7	7	0	7	6	9
	K	4	4	11	11	11	13	15	11	19	13	9	7	6
	L	24	24	26	31	20	17	17	11	7	9	19	9	9
	M	41	28	20	11	9	11	6	19	0	11	2	2	2
	N	19	26	20	20	28	19	17	15	24	17	17	19	13
	O	6	11	15	19	22	30	31	37	43	50	46	57	61
	OBS	54	54	54	54	54	54	54	54	54	54	54	54	54
N	J	3	7	8	7	8	8	12	8	7	8	10	12	13
	K	4	5	5	9	8	10	8	8	7	7	7	2	7
	L	10	8	9	12	11	9	12	10	8	8	9	12	7
	M	6	8	12	5	7	5	6	7	5	3	6	6	2
	N	47	33	25	30	20	16	13	22	22	19	12	16	8
	O	30	40	41	37	45	52	49	45	53	55	56	52	64
	OBS	153	153	153	153	153	153	153	153	153	153	153	153	153
O	J	1	1	3	3	4	5	5	3	2	2	3	5	5
	K	1	1	1	2	3	3	6	5	3	3	4	6	4
	L	1	2	3	4	4	5	6	7	6	5	5	7	5
	M	1	1	2	2	2	2	3	4	2	3	3	4	3
	N	3	4	5	5	6	7	8	10	8	9	7	12	7
	O	94	91	87	83	81	80	72	72	79	78	78	67	75
	OBS	1309	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1309

INITIAL CATEGORY	ALL	J	K	L	M	N	O
PERCENTAGE	100.0	7.3	5.1	6.2	2.9	8.2	70.3
TOTAL OBS	1860	135	95	115	54	153	1308

APPENDIX C

DERIVATION OF OPERATIONAL PARAMETERS PERTAINING TO ALTERNATE AIRPORT CRITERIA

The operational parameters utilized in this study programs were of the form:

$$P(C_N \leq X | C_0 > Y)$$

or

$$P(V_N \leq U | V_0 > W)$$

which are interpreted as;

The probability that the ceiling (visibility) in N hours is less than Category X(U) given the initial category was greater than Y (W).

The conditional probability data available from the cumulative r^2 model are of the form

$$P(C_N \leq X | C_0 \leq Y)$$

or

$$P(V_N \leq U | V_0 \leq W)$$

The derivation of the operational parameters from these data are described in the following paragraphs. The derivation will be carried out for ceilings. The visibility equation derivation is identical in form.

The unconditional probability that the ceiling in N hours will be less than Category X is the sum of the following joint probabilities:

$$P(C_N \leq X) = P(C_N \leq X \oplus C_0 \leq Y) + P(C_N \leq X \oplus C_0 > Y)$$

Solving for $P(C_N \leq X \oplus C_0 > Y)$

$$P(C_N < X \oplus C_0 > Y) = P(C_N \leq X) - P(C_N \leq X \oplus C_0 \leq Y) \qquad (C.1)$$

The two joint probability terms can be written in terms of cumulative conditional probabilities:

$$P(C_N \leq X \oplus C_0 > Y) = P(C_N \leq X | C_0 > Y)\ P(C_0 > Y)$$

$$= P(C_N \leq X | C_0 > Y)\ (1-P(C_0 \leq Y))$$

$$P(C_N \leq X \oplus C_0 \leq Y) = P(C_N \leq X | C_0 \leq Y)\ P(C_0 \leq Y)$$

Equation C.1 may be rewritten as

$$P(C_N \leq X|C_0 > Y) = \frac{P(C_N \leq X) - P(C_N \leq X|C_0 \leq Y)\ P(C_0 \leq Y)}{1 - P(C_0 \leq Y)} \qquad (C.2)$$

As an example of the application of Equation C.2 the cumulative conditional probability data in Table C.1 were converted to the operational parameter format.

Table C.1 Cumulative Conditional Probability Table

CUMULATIVE INITIAL CATEGORY (C_0)	CUMULATIVE SUBSEQUENT CATEGORY (C_1) (Percent)				
	=A	≤B	≤C	≤D	≤E
=A	70.0	86.0	88.0	90.0	97.0
≤B	21.5	82.9	91.1	93.8	97.8
≤C	14.0	59.6	88.9	93.9	97.5
≤D	10.7	45.7	70.8	91.6	97.1
≤E	7.0	31.16	49.2	66.0	95.0

$P(C_0 = A) = 4.4\%$

$P(C_0 \leq B) = 19.1\%$

$P(C_0 \leq C) = 30.1\%$

$P(C_0 \leq D) = 40.6\%$

$P(C_0 \leq E) = 61.4\%$

$P(C_1 = A) = 4.7\%$

$P(C_1 \leq B) = 20.5\%$

$P(C_1 \leq C) = 31.7\%$

$P(C_1 \leq D) = 42.4\%$

$P(C_1 \leq E) = 62.6\%$

Example calculations are as follows:

$$P(C_1 = A|C_0 > A) = \frac{.047 - .70 * .044}{1 - .044} = .0169 = 1.7\%$$

$$P(C_1 = A|C_0 > B) = \frac{.047 - .215 * .191}{1 - .191} = .0073 = 0.7\%$$

$$P(C_1 \leq B|C_0 > A) = \frac{.025 - .860 * .044}{1 - .044} = .1749 = 17.5\%$$

The table of operational parameters is shown in Table C.2.

Table C.2 Operational Parameter Probability Table

CUMULATIVE INITIAL CATEGORY(C_0)	CUMULATIVE SUBSEQUENT CATEGORY (C_1) (Percent)				
	=A	≤B	≤C	≤D	≤E
>A	1.7	17.5	29.1	40.2	61.0
>B	.7	5.8	17.7	30.3	54.3
>C	.7	3.7	7.1	20.2	47.6
>D	.6	3.3	5.0	8.8	39.0
>E	1.0	2.8	3.9	4.9	11.1

APPENDIX D

OPERATIONAL CEILING AND VISIBILITY PARAMETERS FOR TWENTY-FIVE WEATHER STATIONS

In the following tables ceiling and visibility parameters related to alternate airport criteria are presented for twenty-five weather stations. These data were derived through the use of a cumulative r^2 model for deriving conditional probability data from unconditional probability data.

Tables D.1 and D.8 contain the unconditional ceiling and visibility parameters. Tables D.2 through D.7 contain the conditional probabilities for ceilings. Tables D.9 through D.14 contain the conditional probability data for visibilities.

Table D.1 Unconditional Probabilities That The Ceiling will be Less Than Precision and Non-Precision Approach Minimums (Percent)

WEATHER STATION	P(C < 500) (Precision Approach)	P(C < 1000) (Non-Precision Approach)
ASTORIA, OR	2.40%	10.09%
MIAMI, FL	.35	.96
SAN FRANCISCO, CA	1.81	7.90
TYNDALL, FL	3.60	6.43
BILOXI, MS	4.17	7.95
MYRTLE BEACH, SC	2.60	6.11
ELLINGTON AB, TX	3.56	8.24
KINGSVILLE, TX	2.79	8.10
ATLANTIC CITY, NJ	5.56	11.23
BRUNSWICK, ME	9.08	15.30
SMYRNA, TN	1.60	5.13
MILWAUKEE, WI	3.82	8.39
FT. KNOX, KY	2.49	6.33
OFFUTT AFB, NE	1.89	5.57
PITTSBURGH, PA	3.58	8.19
DYESS AFB, TX	2.01	5.33
NELLIS AFB, NV	.00	.00
FAIRCHILD AFB, WA	6.57	10.91
BILLINGS, MT	1.44	3.48
WINSLOW, AZ	.23	.63
COLORADO SPRINGS, CO	2.32	4.63
TRAVIS, CA	2.96	6.39
OTIS, MA	11.11	17.70
SAN CLEMENTE, CA	4.38	[illegible]
MONTAGUE, CA	1.24	[illegible]
MEAN VALUE	3.27%	7.45%

Table D.2 Probabilities That the Ceiling will be Below Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in One Hour (Percent)

WEATHER STATION	$P(C_1 < 500/C_0 > 1000)$ (Proposed)	$P(C_1 < 500/C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	.28%	.22%	.06%
MIAMI, FL	.04	.03	.01
SAN FRANCISCO, CA	.21	.16	.05
TYNDALL, FL	.44	.34	.10
BILOXI, MS	.51	.39	.12
MYRTLE BEACH, SC	.32	.24	.08
ELLINGTON AB, TX	.43	.33	.10
KINGSVILLE, TX	.36	.28	.08
ATLANTIC CITY, NJ	.69	.53	.16
BRUNSWICK, ME	1.10	.85	.25
SMYRNA, TN	.20	.15	.05
MILWAUKEE, WI	.46	.36	.10
FT. KNOX, KY	.29	.23	.06
OFFUTT AFB, NE	.22	.17	.05
PITTSBURGH, PA	.43	.33	.10
DYESS AFB, TX	.24	.19	.05
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	.79	.61	.18
BILLINGS, MT	.17	.13	.04
WINSLOW, AZ	.03	.02	.01
COLORADO SPRINGS, CO	.28	.22	.05
TRAVIS, CA	.35	.27	.08
OTIS, MA	1.35	1.04	.31
SAN CLEMENTE, CA	.53	.41	.12
MONTAGUE, CA	.15	.11	.04
MEAN VALUE	.39%	.30%	.09%

Table D.3 Probabilities That the Ceiling Will Be Below Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in One Hour (Percent)

WEATHER STATION	$P(C_1 < 1000 \mid C_0 > 1000)$ (Proposed)	$P(C_1 < 1000 \mid C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	2.00%	1.02%	.98%
MIAMI, FL	.16	.09	.07
SAN FRANCISCO, CA	1.79	.79	1.00
TYNDALL, FL	1.28	.65	.63
BILOXI, MS	1.47	.80	.67
MYRTLE BEACH, SC	1.17	.61	.56
ELLINGTON AB, TX	1.57	.82	.75
KINGSVILLE, TX	1.60	.81	.79
ATLANTIC CITY, NJ	2.09	1.13	.96
BRUNSWICK, ME	2.64	1.53	1.11
SMYRNA, TN	.92	.51	.41
MILWAUKEE, WI	1.48	.84	.64
FT. KNOX, KY	1.28	.68	.60
OFFUTT AFB, NE	1.00	.56	.44
PITTSBURGH, PA	1.49	.82	.67
DYESS AFB, TX	1.04	.54	.50
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	1.92	1.09	.83
BILLINGS, MT	.59	.35	.24
WINSLOW, AZ	.10	.06	.04
COLORADO SPRINGS, CO	.85	.46	.39
TRAVIS, CA	1.32	.64	.68
OTIS, MA	3.04	1.83	1.21
SAN CLEMENTE, CA	3.57	1.90	1.67
MONTAGUE, CA	.36	.19	.17
MEAN VALUE	1.39%	.75%	.64%

Table D.4 **Probabilities That the Ceiling Will Be Below Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in Three Hours (Percent)**

WEATHER STATION	$P(C_3 < 500/C_0 > 1000)$ (Proposed)	$P(C_3 < 500/C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	.69 %	.54 %	.15 %
MIAMI, FL	.12	.08	.04
SAN FRANCISCO, CA	.52	.41	.11
TYNDALL, FL	1.05	.32	.23
BILOXI, MS	1.19	.95	.24
MYRTLE BEACH, SC	.74	.59	.15
ELLINGTON AFB, TX	1.01	.31	.20
KINGSVILLE, TX	.86	.68	.18
ATLANTIC CITY, NJ	1.61	1.29	.32
BRUNSWICK, ME	2.58	2.07	.51
SMYRNA, TN	.47	.35	.11
MILWAUKEE, WI	1.09	.87	.22
FT. KNOX, KY	.72	.57	.15
OFFUTT AFB, NE	.54	.43	.11
PITTSBURGH, PA	1.03	.81	.22
DYESS AFB, TX	.57	.45	.11
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	1.39	1.49	.40
BILLINGS, MT	.42	.33	.09
WINSLOW, AZ	.07	.05	.02
COLORADO SPRINGS, CO	.69	.53	.16
TRAVIS, CA	.86	.67	.19
OTIS, MA	3.16	2.53	.63
SAN CLEMENTE, CA	1.24	.99	.25
MONTAGUE, CA	.37	.28	.09
MEAN VALUE	.94 %	.74 %	.20 %

Table D.5 Probabilities That the Ceilings Will Be Below Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in Three Hours (Percent)

WEATHER STATION	$P(C_3 < 1000/C_0 > 1000)$ (Proposed)	$P(C_3 < 1000/C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	4.02%	2.46%	1.56%
MIAMI, FL	.45	.23	.22
SAN FRANCISCO, CA	3.32	1.96	1.36
TYNDALL, FL	2.68	1.59	1.08
BILOXI, MS	3.11	1.94	1.17
MYRTLE BEACH, SC	2.41	1.49	.92
ELLINGTON AB, TX	3.33	2.02	1.31
KINGSVILLE, TX	3.41	1.98	1.43
ATLANTIC CITY, NJ	4.10	2.74	1.36
BRUNSWICK, ME	5.40	3.75	1.65
SMYRNA, TN	1.98	1.25	.73
MILWAUKEE, WI	3.00	2.05	.95
FT. KNOX, KY	2.63	1.67	.96
OFFUTT AFB, NE	2.13	1.36	.77
PITTSBURGH, PA	3.03	2.00	1.03
DYESS AFB, TX	2.10	1.31	.79
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	4.05	2.66	1.39
BILLINGS, MT	1.37	.85	.52
WINSLOW, AZ	.26	.15	.11
COLORADO SPRINGS, CO	1.84	1.13	.71
TRAVIS, CA	2.71	1.58	1.13
OTIS, MA	6.27	4.40	1.87
SAN CLEMENTE, CA	7.55	4.64	2.91
MONTAGUE, CA	.75	.47	.28
MEAN VALUE	2.90%	1.83%	1.07%

Table D.6 Probabilities That the Ceilings Will Be Below Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in Six Hours (Percent)

WEATHER STATION	$P(C_6 < 500 / C_0 > 1000)$ (Proposed)	$P(C_6 < 500 / C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	1.09 %	.92 %	.17 %
MIAMI, FL	.21	.14	.07
SAN FRANCISCO, CA	.88	.70	.18
TYNDALL, FL	1.75	1.39	.35
BILOXI, MS	1.94	1.61	.33
MYRTLE BEACH, SC	1.23	1.01	.22
ELLINGTON AB, TX	1.65	1.38	.27
KINGSVILLE, TX	1.37	1.15	.22
ATLANTIC CITY, NJ	2.57	2.18	.39
BRUNSWICK, ME	4.18	3.51	.67
SMYRNA, TN	.74	.63	.11
MILWAUKEE, WI	1.73	1.48	.25
FT. KNOX, KY	1.17	.96	.21
OFFUTT AFB, NE	.85	.73	.12
PITTSBURGH, PA	1.63	1.38	.25
DYESS AFB, TX	.90	.78	.12
NELLIS AFB, NV	.09	.09	.00
FAIRCHILD AFB, WA	3.00	2.54	.45
BILLINGS, MT	.67	.55	.12
WINSLOW, AZ	.11	.09	.02
COLORADO SPRINGS, CO	1.15	.90	.25
TRAVIS, CA	1.41	1.15	.25
OTIS, MA	5.15	4.29	.86
SAN CLEMENTE, CA	1.97	1.69	.28
MONTAGUE, CA	.61	.48	.13
MEAN VALUE	1.52 %	1.27 %	.25 %

Table D.7 Probabilities That the Ceilings Will Be Below Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in Six Hours (Percent)

WEATHER STATION	$P(C_6 < 1000/C_0 > 1000)$ (Proposed)	$P(C_6 < 1000/C_0 > 3000)$ (Current)	Difference
ASTORIA, OR	5.78%	4.14 %	1.64 %
MIAMI, FL	.64	.39	.25
SAN FRANCISCO, CA	5.58	3.57	2.01
TYNDALL, FL	3.90	2.73	1.17
BILOXI, MS	4.57	3.27	1.30
MYRTLE BEACH, SC	3.50	2.51	.99
ELLINGTON AB, TX	4.94	3.39	1.55
KINGSVILLE, TX	4.98	3.37	1.61
ATLANTIC CITY, NJ	6.07	4.61	1.46
BRUNSWICK, ME	7.98	6.39	1.59
SMYRNA, TN	2.88	2.13	.75
MILWAUKEE, WI	4.38	3.44	.94
FT. KNOX, KY	3.30	2.37	.93
OFFUTT AFB, NE	3.13	2.28	.85
PITTSBURGH, PA	4.36	3.36	1.00
DYESS AFB, TX	3.08	2.21	.87
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	5.96	4.51	1.45
BILLINGS, MT	1.99	1.43	.56
WINSLOW, AZ	.37	.26	.11
COLORADO SPRINGS, CO	2.74	1.91	.83
TRAVIS, CA	3.91	2.76	1.15
OTIS, MA	9.25	7.46	1.79
SAN CLEMENTE, CA	10.31	7.29	3.02
MONTAGUE, CA	1.09	.79	.30
MEAN VALUE	4.28 %	3.15 %	1.13 %

Table D.8 Unconditional Probability That the Visibilities Will Be Less Than Precision and Non-Precision Approach Minimums (Percent)

WEATHER STATION	P(V < .5) (Precision Approach)	P(V < 1) (Non-Precision Approach)
ASTORIA, OR	1.40%	2.19%
MIAMI, FL	.18	.26
SAN FRANCISCO, CA	.76	1.17
TYNDALL, FL	1.74	2.40
BILOXI, MS	2.11	2.96
MYRTLE BEACH, SC	.38	1.55
ELLINGTON AFB, TX	1.77	2.32
KINGSVILLE, TX	1.30	1.95
ATLANTIC CITY, NJ	2.04	3.73
BRUNSWICK, ME	3.46	5.34
SMYRNA, TN	.67	1.38
MILWAUKEE, WI	1.35	2.48
FT. KNOX, KY	.77	1.69
OFFUTT AFB, NE	.76	1.58
PITTSBURGH, PA	.71	1.80
DYESS AFB, TX	.34	.74
NELLIS AFB, NV	.00	.01
FAIRCHILD AFB, WA	2.97	4.59
BILLINGS, MT	.57	1.23
WINSLOW, AZ	.08	.20
COLORADO SPRINGS, CO	.92	1.73
TRAVIS, CA	1.36	2.22
OTIS, MA	3.64	5.49
SAN CLEMENTE, CA	1.21	1.98
MONTAGUE, CA	1.35	1.68
MEAN VALUE	1.29%	2.21%

Table D.9 Probabilities That the Visibility Will Be Less Than Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in One Hour (Percent)

WEATHER STATION	$P(V_1 < .5 \mid V_o > 1)$ (Proposed)	$P(V_1 < .5 \mid V_o > 3)$ (Current)	Difference
ASTORIA, OR	.21%	.10%	.11%
MIAMI, FL	.04	.01	.03
SAN FRANCISCO, CA	.11	.06	.05
TYNDALL, FL	.29	.13	.15
BILOXI, MS	.33	.16	.17
MYRTLE BEACH, SC	.13	.06	.07
ELLINGTON AB, TX	.28	.14	.14
KINGSVILLE, TX	.23	.10	.13
ATLANTIC CITY, NJ	.31	.15	.16
BRUNSWICK, ME	.53	.26	.27
SMYRNA, TN	.11	.05	.06
MILWAUKEE, WI	.20	.10	.10
FT. KNOX, KY	.11	.06	.05
OFFUTT AFB, NE	.11	.05	.06
PITTSBURGH, PA	.13	.05	.08
DYESS AFB, TX	.05	.03	.02
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	.47	.23	.24
BILLINGS, MT	.09	.04	.05
WINSLOW, AZ	.01	.01	.00
COLORADO SPRINGS, CO	.14	.07	.07
TRAVIS, CA	.23	.10	.13
OTIS, MA	.56	.27	.29
SAN CLEMENTE, CA	.18	.09	.09
MONTAGUE, CA	.23	.10	.13
MEAN VALUE	.20%	.10%	.11%

Table D.10 Probabilities That the Visibility Will Be Less Than Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in One Hour (Percent)

WEATHER STATION	$P(V_1<1 \mid V_0>1)$ (Proposed)	$(P(V_1<1 \mid V_0>3)$ (Current)	Differenc
ASTORIA, OR	.70%	.27%	.43%
MIAMI, FL	.07	.03	.04
SAN FRANCISCO, CA	.36	.15	.21
TYNDALL, FL	.72	.30	.42
BILOXI, MS	.89	.37	.52
MYRTLE BEACH, SC	.44	.19	.25
ELLINGTON AB, TX	.88	.35	.53
KINGSVILLE, TX	.66	.25	.41
ATLANTIC CITY, NJ	1.09	.47	.62
BRUNSWICK, ME	1.81	.79	1.02
SMYRNA, TN	.39	.17	.22
MILWAUKEE, WI	.61	.30	.31
FT. KNOX, KY	.43	.20	.23
OFFUTT AFB, NE	.42	.21	.21
PITTSBURGH, PA	.53	.22	.31
DYESS AFB, TX	.18	.09	.09
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	1.26	.57	.69
BILLINGS, MT	.31	.15	.16
WINSLOW, AZ	.05	.02	.03
COLORADO SPRINGS, CO	.42	.21	.21
TRAVIS, CA	.74	.28	.46
OTIS, MA	1.85	.81	1.04
SAN CLEMENTE, CA	.51	.24	.27
MONTAGUE, CA	.51	.21	.30
MEAN VALUE	.63%	.27%	.36%

Table D.11 Probabilities That the Visibility Will Be Less Than Precision Approach Minimums for Current and Proposed Alternate Airport Criteria In Three Hours (Percent)

WEATHER STATION	$P(V_3 < .5/V_o > 1)$ (Proposed)	$P(V_3 < .5/V_o > 3)$ (Current)	Difference
ASTORIA, OR	.64%	.38%	.26%
MIAMI, FL	.12	.08	.04
SAN FRANCISCO, CA	.37	.21	.16
TYNDALL, FL	.82	.49	.33
BILOXI, MS	.88	.58	.30
MYRTLE BEACH, SC	.41	.24	.17
ELLINGTON AB, TX	.78	.49	.29
KINGSVILLE, TX	.65	.37	.28
ATLANTIC CITY, NJ	.84	.55	.28
BRUNSWICK, ME	1.37	.95	.42
SMYRNA, TN	.32	.20	.12
MILWAUKEE, WI	.55	.37	.18
FT. KNOX, KY	.33	.22	.11
OFFUTT AFB, NE	.32	.21	.11
PITTSBURGH, PA	.36	.20	.16
DYESS AFB, TX	.14	.09	.05
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	1.21	.85	.36
BILLINGS, MT	.23	.16	.07
WINSLOW, AZ	.03	.02	.01
COLORADO SPRINGS, CO	.37	.26	.11
TRAVIS, CA	.69	.38	.31
OTIS, MA	1.43	1.00	.43
SAN CLEMENTE, CA	.50	.33	.17
MONTAGUE, CA	.67	.42	.25
MEAN VALUE	.56%	.36%	.20%

Table D.12 Probabilities That the Visibility Will Be Less Than Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria In Three Hours (Percent)

WEATHER STATION	$P(V_3 < 1 / V_o > 1)$ (Proposed)	$P(V_3 < 1 / V_o > 3)$ Current	Difference
ASTORIA, OR	1.33%	.73%	.60%
MIAMI, FL	.20	.11	.09
SAN FRANCISCO, CA	.72	.40	.32
TYNDALL, FL	1.41	.83	.58
BILOXI, MS	1.63	.96	.67
MYRTLE BEACH, SC	.95	.53	.42
ELLINGTON AFB, TX	1.67	.97	.70
KINGSVILLE, TX	1.26	.69	.57
ATLANTIC CITY, NJ	2.12	1.23	.89
BRUNSWICK, ME	3.39	2.05	1.34
SMYRNA, TN	.81	.48	.33
MILWAUKEE, WI	1.26	.80	.46
FT. KNOX, KY	.95	.55	.40
OFFUTT AFB, NE	.87	.54	.33
PITTSBURGH, PA	1.14	.58	.56
DYESS AFB, TX	.42	.25	.17
NELLIS AFB, NV	.01	.00	.01
FAIRCHILD AFB, WA	2.35	1.54	.81
BILLINGS, MT	.66	.40	.26
WINSLOW, AZ	.12	.07	.05
COLORADO SPRINGS, CO	.92	.57	.35
TRAVIS, CA	1.45	.81	.64
OTIS, MA	3.46	2.10	1.36
SAN CLEMENTE, CA	1.07	.64	.43
MONTAGUE, CA	.98	.65	.33
MEAN VALUE	1.25%	.74%	.51%

Table D.13 Probabilities That the Visibility Will Be Less Than Precision Approach Minimums for Current and Proposed Alternate Airport Criteria in Six Hours (Percent)

WEATHER STATION	$P(V_6 < .5/V_o > 1)$ (Proposed)	$P(V_6 < .5/V_o > 3)$ (Current)	Difference
ASTORIA, OR	1.02%	.63%	.39%
MIAMI, FL	.17	.13	.04
SAN FRANCISCO, CA	.56	.34	.22
TYNDALL, FL	1.25	.84	.41
BILOXI, MS	1.40	.89	.51
MYRTLE BEACH, SC	.58	.33	.25
ELLINGTON AB, TX	1.26	.81	.45
KINGSVILLE, TX	1.02	.63	.39
ATLANTIC CITY, NJ	1.32	.85	.47
BRUNSWICK, ME	2.12	1.44	.68
SMYRNA, TN	.47	.32	.15
MILWAUKEE, WI	.78	.56	.22
FT. KNOX, KY	.49	.34	.15
OFFUTT AFB, NE	.48	.32	.16
PITTSBURGH, PA	.50	.29	.21
DYESS AFB, TX	.21	.16	.05
NELLIS AFB, NV	.00	.00	.00
FAIRCHILD AFB, WA	1.72	1.29	.43
BILLINGS, MT	.33	.24	.09
WINSLOW, AZ	.06	.03	.03
COLORADO SPRINGS, CO	.55	.39	.16
TRAVIS, CA	1.05	.67	.38
OTIS, MA	2.20	1.52	.68
SAN CLEMENTE, CA	.72	.50	.22
MONTAGUE, CA	.96	.76	.20
MEAN VALUE	.85%	.57%	.28%

Table D.14 Probabilities That the Visibility Will Be Less Than Non-Precision Approach Minimums for Current and Proposed Alternate Airport Criteria In Six Hours (Percent)

WEATHER STATION	$P(V_6 < 1/V_0 > 1)$ (Proposed)	$P(V_6 < 1/V_0 > 3)$ (Current)	Difference
ASTORIA, OR	1.78%	1.23%	.55 %
MIAMI, FL	.26	.22	.04
SAN FRANCISCO, CA	.92	.65	.27
TYNDALL, FL	1.87	1.46	.41
BILOXI, MS	2.18	1.53	.65
MYRTLE BEACH, SC	1.27	.87	.40
ELLINGTON AB, TX	2.25	1.55	.70
KINGSVILLE, TX	1.65	1.24	.41
ATLANTIC CITY, NJ	2.30	1.97	.33
BRUNSWICK, ME	4.46	3.20	1.26
SMYRNA, TN	1.05	.77	.28
MILWAUKEE, WI	1.62	1.25	.37
FT. KNOX, KY	1.22	.88	.34
OFFUTT AFB, NE	1.17	.85	.32
PITTSBURGH, PA	1.39	.91	.48
DYESS AFB, TX	.54	.39	.15
NELLIS AFB, NV	.01	.01	.00
FAIRCHILD AFB, WA	3.13	2.39	.74
BILLINGS, MT	.86	.64	.22
WINSLOW, AZ	.15	.11	.04
COLORADO SPRINGS, CO	1.21	.93	.28
TRAVIS, CA	1.91	1.37	.54
OTIS, MA	4.50	3.30	1.20
SAN CLEMENTE, CA	1.38	.99	.39
MONTAGUE, CA	1.27	1.09	.18
MEAN VALUE	1.63 %	1.20 %	.44 %